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ABSTRACT

A project examined technology transfer programs and developed a model for use by Wisconsin's Vocational, Technical, and Adult Education (VTAE) system that would involve cooperative efforts with the University of Wisconsin and other agencies. Staff reviewed literature on technology transfer and visited six technology transfer organizations. The literature suggested that the successful transfer of new technology required the receiving company to have a perceived need. The receiving company needed assistance in selecting the appropriate technology and preparing employees to use it and follow-up help with any problems. A variety of activities were reported as being involved in technology transfer, ranging from basic research to the application of off-the-shelf technology to common problems in business and industry. Using this information, an advisory committee recommended that the Wisconsin VTAE Model focus on technology deployment and education activities and services; be based on an active approach to technology transfer; and involve a variety of partners in delivering services to companies. A state-level coordinating center and regional technology transfer centers were proposed. (Eight references are listed. Appendixes, amounting to approximately one-half of the report, include advisory committee members, agendas, and meeting minutes; site visit reports; and a literature review on technology transfer.) (YLB)

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ED329676

Final Report

A Joint Project

of

Wisconsin Board of VTAE

and

UW-Stout

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Development of a Model for a Technology Transfer System That Includes the Wisconsin VTAE System and UW-Stout

December, 1990

CE057064

Grant Numbers 30-109-150-290 and 30-109-150-291

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Abstract

Technology Transfer Model

During the last two decades, dramatic changes in technology and the globalization of our marketplace have had significant impacts on business and industry in the United States and Wisconsin. Large companies often find it difficult to cope with these changes. Medium and small companies frequently find that it is impossible for them to adjust to these changes without help. Several programs have been created to help these companies adjust and respond. Every state has one or more programs created and designed to foster economic development. In some respects these programs have grown like topsy. Most states have several programs, directed by a variety of agencies, to encourage and direct economic development. The National Institute for Science and Technology in a study conducted in 1988 found that there were more than 200 organizations providing help and assistance with technology transfer.

The purpose of this project was to examine technology transfer programs and develop a model that could be used by Wisconsin's VTAE System and would involve cooperative efforts with UW System campuses and other agencies. Project staff members reviewed a wide variety of literature on technology transfer and the evaluation of these programs. In addition, the staff visited six technology transfer organizations. This abstract presents the major findings and recommendations that resulted from these activities. The report provides a detailed discussion.

Many of the studies reviewed indicated that small to medium sized companies have the most need for assistance with identifying and applying new technology in their operations. After reviewing several studies, it became apparent that the successful transfer of new technology requires the receiving company to have a perceived or felt need to enhance its technology. It must also have assistance in selecting the appropriate technology, preparing employees to use it, and follow-up help with any problems that may result from deploying this technology.

A variety of activities can be involved in technology transfer. These can range from basic research on one end of the continuum to the application of off-the-shelf technology to common problems in business and industry. The programs reviewed include components from the entire spectrum. Some emphasize the research and development end of the continuum. Others place primary emphasis on the transfer or deployment of proven technology.

Most of the technology transfer assistance provided in the United States is focused on giving access to existing or off-the-shelf technology. The NIST Study referred to previously found that

almost two-thirds of the assistance given was directed to helping companies use proven technology.

Another way to look at technology transfer programs is by the type of involvement they have with their clients in business and industry. This analysis leads to an active-passive continuum. Passive technology transfer programs are those that primarily serve as referral and brokering agencies. Companies that contact these organizations are referred to other organizations, people and agencies who have the appropriate information and skills. Active programs are those that go on-site and assist a company to identify its needs, select the appropriate technology, participate in the training process and provide follow-up problem solving assistance. The research reviewed indicated that the active technology transfer programs were uniformly successful and had significant impacts. The passive programs had moderate to little impact.

A primary purpose of technology transfer is keeping the United States, individual states and localities within these states competitive in a world market. To do this, many projects focus on keeping the business/industry climate healthy and on retaining, upgrading, and creating new jobs in the region served. Most technology transfer projects are joint efforts of technical colleges, universities, and other organizations.

Staff members of technology transfer organizations work to connect those in need of service with people who are in position to provide these services. They work to develop teams of experts who can assist a company. These experts may come form technical colleges, universities, financial institutions and other organizations that can provide technical expertise.

Costs reported by various technology transfer organizations ranged widely. The cost per client reported in the 1988 NIST survey ranged from $500 to $143,000 per firm. The organizations that emphasize referral services averaged about $1,100 per client. Those programs that provided active technology assistance and worked closely with their clients ranged form $18,000 to more than $100,000 per client. The average staff size of technology transfer organizations was 20. Typically these organizations have a blend of technology/engineering, management, and business oriented expertise.

Information on various technology transfer models and components of these programs was presented to the project's advisory committee during its June, 1990, meeting. Based on this information and the members' knowledge of technology transfer, the advisory committee recommended that the Wisconsin VTAE Model:

- Focus on technology deployment and education activities and services.
- Be based on an active approach to technology transfer
- Involve a variety of partners in delivering services to companies.

The technology transfer model presented in this paper was designed to provide technology deployment and training to companies that want to become more productive and competitive. Active and brokering technology transfer processes will be used. Linkages and cooperation between companies, educational institutions, government agencies, and other organizations concerned with technology transfer are encouraged.

A state-level coordinating center and regional technology transfer centers are proposed. The state-level center will coordinate the work of the regional centers, network with state agencies and organizations, interface with agencies and organizations outside of Wisconsin, and evaluate the impacts of the technology transfer program.

The regional centers will have a core staff that can devote its total effort to technology transfer. Staff members will be selected to have expertise in needs assessment, technology selection, system design and human resource development. They will be able to plan and conduct active technology transfer projects. Action teams comprised of technical college and university teachers will work with regional center staff members on these technology transfer projects. In some projects, students will also be involved. Teachers and students will usually participate on a team during one school term.

This model will provide access to a range of expertise. It will also provide the experiences and information technical college and university instructors need to keep their courses current with technology. Participating companies will receive the assistance they need to be competitive.

Problem and Objectives

Introduction

The purpose of this project was to identify technology transfer models and procedures used by technology transfer centers and develop a functional technology transfer model for the Wisconsin VTAE System. Project staff visited technology transfer centers in several regions of the United States to identify the models and ascertain what procedures were effective. Barriers to technology transfer were also investigated. In addition, a variety of literature on technology transfer was studied.

This information was used to develop a model for Wisconsin. This report presents the model and discusses the types of technology transfer services associated with it.

Purpose

This project had a twofold purpose:

1. Identify the roles the Wisconsin VTAE System and UW-Stout can play in technology transfer to Wisconsin business and industry, and;
2. Develop a plan for a technology transfer system that provides services and resources that support this process.

The system was designed to transfer proven applications of new technology. This system was not designed to create technology.

Objectives

This project was designed to explore the technology transfer process, determine the factors that make technology transfer centers effective, and develop a plan for a technology transfer system that utilizes the expertise of the Wisconsin VTAE System and UW-Stout. Hence, the project objectives focused on the technology transfer process and what other organizations have done to facilitate this process.

The project objectives were to:

1. Identify factors and conditions that facilitate the transfer of technology to functional operating systems in B/I.
2. Develop summary descriptions of various approaches/models used by technology transfer centers.
3. Describe technology transfer models developed by researchers.
4. Isolate variables, services and conditions that facilitate the effectiveness of technology transfer centers.
5. Identify factors, approaches and conditions that inhibit the effectiveness of technology transfer centers.
6. Determine the resources needed to support an effective technology transfer system.
7. Develop a minimum of three technology transfer models that could be used by the Wisconsin VTAE System.
8. Develop a plan for a technology transfer system for Wisconsin that includes integral roles for the Wisconsin VTAE System and UW-Stout.
9. Determine the resources required to operate the technology transfer system.
10. Prepare a report of the findings that can be disseminated to people in business, industry, government and education.

Approach

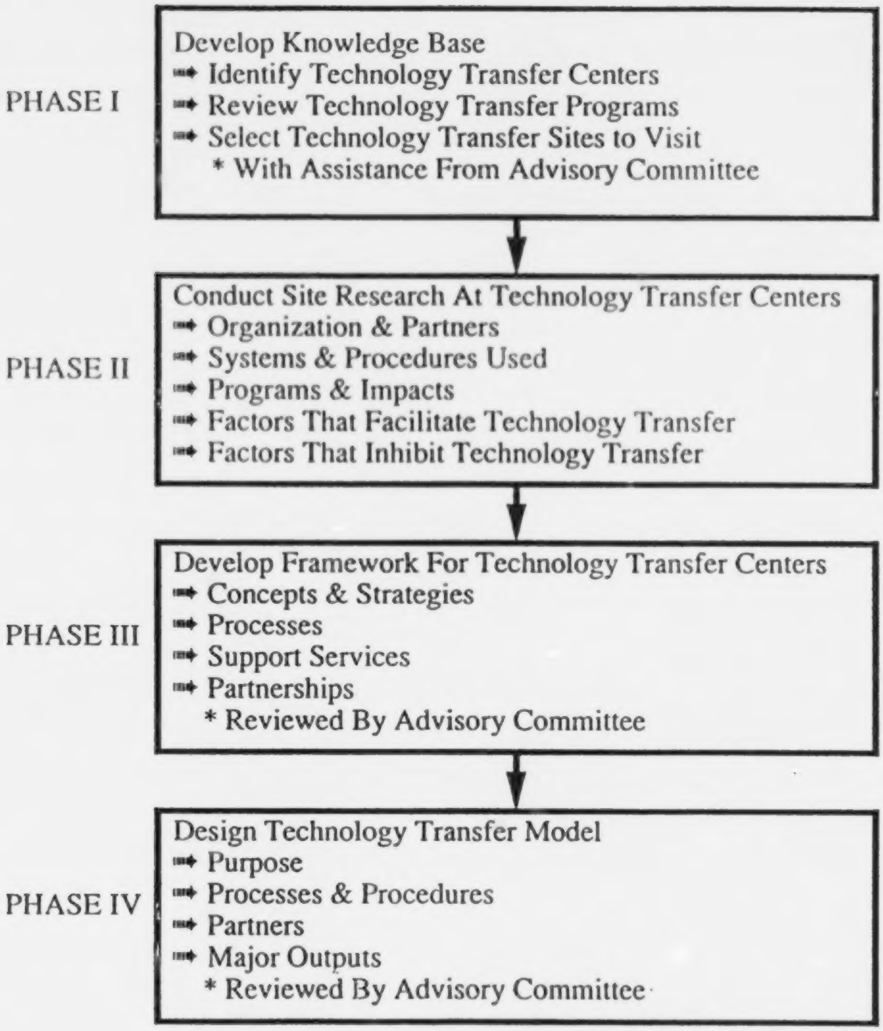
Research Design

Two major sources of information were used in this study. Literature and documents on technology transfer were studied and personal interviews were conducted with technology transfer center staff and clients. Data collected from these sources were analyzed to determine the most appropriate and effective roles of centers that transfer technology to business and industrial operations. The results of these analyses were used to design a model that can be used by the Wisconsin VTAE System and UW-Stout. The major phases in this research project are shown in Figure 1. Further definitions of these phases will be given in the research activity schedule.

Advisory Committee

An advisory committee of six individuals was selected by Dwight York and Charles Sorensen. A list of the advisory committee members is given in Appendix A. Committee members provided

FIGURE 1: Major Phases In The Technology Transfer Project


PHASE I
Develop Knowledge Base
➡ Identify Technology Transfer Centers
➡ Review Technology Transfer Programs
➡ Select Technology Transfer Sites to Visit
* With Assistance From Advisory Committee
PHASE II
Conduct Site Research At Technology Transfer Centers
➡ Organization & Partners
➡ Systems & Procedures Used
➡ Programs & Impacts
➡ Factors That Facilitate Technology Transfer
➡ Factors That Inhibit Technology Transfer
PHASE III
Develop Framework For Technology Transfer Centers
➡ Concepts & Strategies
➡ Processes
➡ Support Services
➡ Partnerships
* Reviewed By Advisory Committee
PHASE IV
Design Technology Transfer Model
➡ Purpose
➡ Processes & Procedures
➡ Partners
➡ Major Outputs
* Reviewed By Advisory Committee

input on technology transfer centers and assisted in the process of selecting the centers for site visits. The committee also critiqued the technology transfer framework and technology transfer model. Suggestions and recommendations from the advisory committee members played a key role in shaping the final products developed by this project.

Three advisory committee meetings were held. A copy of the minutes of each meeting is included in Appendix A. The first meeting focused on sources of information on technology transfer and sites to visit. A framework for technology transfer and components for a model were presented and discussed at the second meeting. During this session, advisory committee members recommended that the model be based on:

- the transfer of existing technology-technology deployment, and
- the application of an active transfer process.

These recommendations were used to develop the model that was presented at the third meeting. At this meeting committee members made several comments that were used to refine the model.

Research Activities

The research activities on these projects were conducted during the period from March 15 through October 31, 1990. Site visits were completed in June. A detailed list of activities is given in Appendix B.

Before reviewing the research activities, the difference between the framework and model for technology transfer needs to be discussed. The framework developed in Phase II of the project presented a general description of the elements, conditions and resources required for an effective technology transfer system. The framework was developed without specific reference to Wisconsin resources, conditions and needs. This allowed the researchers and the advisory committee to evaluate the framework from a relatively bias free perspective.

After the framework was accepted by the advisory committee, the project used it to guide the design of a technology transfer model for Wisconsin. The model design took into account factors, conditions and resources in Wisconsin. In addition, it describes a potential network of technical colleges and companies that could be involved in technology transfer. A cost estimate for the first two years of operation was also prepared.

During the first phase of the project, staff members and a graduate research assistant reviewed information on technology transfer and technology transfer centers. The electronic data base retrieval systems in the UW-Stout library were used to access this information. In addition to searching on technology transfer, useful literature was found under technology assessment and technology forecasting. A number of references were found. Most of these are included in the reference list at the end of this report or in the appendices. Summaries of selected documents are included in the results section and in the appendices.

This literature review and recommendations from advisory committee members formed the basis for selecting the sites to visit. Six sites were visited. These were:

- Unified Technology Center, Cuyahoga Community College, Cleveland, Ohio
- Greater Minnesota Corporation, Minneapolis, Minnesota
- Minnesota Advanced Manufacturing Center, Minneapolis, Minnesota
- The National Institute of Standards and Technology, Gaithersburg, Maryland
- Camden Community College, Camden, New Jersey
- Trident Community College, Charleston, South Carolina

In addition to these site visits, project staff members visited with faculty members from the Northeast Wales Institute of Higher Education, and the technical college at Okmulgee, Oklahoma. State agency staff members in Georgia, Arizona and Indiana were interviewed by telephone.

During the site visits, staff members reviewed the components of the technology transfer program, obtained information on the strategies utilized, acquired information on the budget resources available, and identified factors that facilitated and inhibited technology transfer. All of the people associated with the sites visited were very cooperative and helpful. NIST staff members were especially helpful in providing a wide range of information on technology transfer and research going on in this area.

Using the information collected from the site visits and the review of literature, project staff members put together a framework for technology transfer. The framework included a list of components and strategies that are found in various technology transfer programs across the country. The components included:

- Technology Deployment and Training
- Technology Education

- Climate, Communication and Linkages
- Facilities
- Finance and Governance
- Future Studies
- Small Business Centers
- Basic Research
- Research, Development and Evaluation
- GEO-Political
- R&D Grants
- Venture Capital

An outline of the purpose and potential activities listed under each of these is given in Appendix D. More detailed descriptions will be presented for those components selected as integral parts of the model for the VTAE System. These components were presented to the advisory committee.

The technology transfer process was also reviewed on the basis of active vs. passive approaches. A passive approach includes information giving and referral activities. Active approaches include actual on-site assistance with the transfer of technology to a specific plant site.
During the second advisory committee meeting on June 16, committee members recommended that technology deployment and training be the focal point of the model. In addition, committee members wanted the model to emphasize the active approach. They also recommended that basic research not be an objective of the model.

Project staff members took these recommendations and developed a final technology transfer model. After the model had been designed a budget was prepared. The model and the budget were reviewed during the third advisory committee meeting. The specific details of the final model and the budget will be presented in the results section.

The results of the project activities were presented to the Wisconsin Board of VTAE and the administrators in the School of Industry and Technology at UW-Stout for the preparation of budget requests for the next fiscal biennium.

Results

This section will present the results of the technology transfer project. Results are presented by project objective. In some instances the objectives overlap and the discussions will be correlated.

1. Identify factors and conditions that facilitate the transfer of technology to business and industry.

An important starting point in transferring technology is an understanding or awareness on the part of the company that it needs to use new technology. Studies of technology transfer indicate that it is difficult to push technology out from universities and research centers into companies if there is not a perceived need (NSF, 1983). A company may become aware of a need through several different avenues. For example, it may see its competitors using new technology and gaining an increasing market share because of better quality and/or lower costs. Some companies monitor the developments in research centers or have their own R& D laboratories to develop new technology. In other instances, a private inventor may bring a new technology or product to a company.

For many small and medium-size companies, there is considerable delay in time between the development of a new technology and when they adopt it. Several factors influence this. For example, a study done in Sweden indicated that there was a five to ten year lag in the metal working field between the time when the first and last adopters received their information on a new technology (Bright, 1978). Bright also noted that the following factors have a significant impact on the speed at which a company will adopt new technology (p. 37).

- Ample funds that could be committed to the technology.
- Appropriate supporting technologies are available.
- The new technology will displace a relatively small amount of existing capital investment.
- The new technology will fit into the existing organizational structure.
- The new technology will not challenge any of the company's values and traditions.

Osborn took a different approach in studying technology transfer. Instead of looking at programs, he looked at four basic problems he perceived were barriers to technology development. These problems included:

- The lack of a sufficient research base to simulate development of new technologies.
- Insufficient transfer of technological knowledge from research institutions to the corporate world.
- Inadequate funding and other support services for new enterprises.
- Inadequate deployment of new technologies by current manufacturers and businesses.

Osborn concluded that programs were needed to address these problems (1989, pp. 6-7). In a study done by the Technology Management Center in Pennsylvania, it was found that many small companies were not intending to implement new technology. The problem did not appear to be one of having new technology available, rather it was one of the companies being somewhat afraid or concerned about the new technologies (Koppel, 1986, pp. 12-43). This research pointed out the need for people in the company to become familiar with and understand new technology.

After reviewing several studies, it became apparent that the successful transfer of new technology requires that the receiving company have a perceived or identified need to enhance its technology. In addition, it must have assistance in selecting the appropriate technology, preparing its employees for using the technology and follow-up help with any problems that may ensue as result of deploying new technology.

These same factors were experienced by UW-Stout's Manufacturing Technology Transfer Center as it has worked with several companies in Wisconsin. The first company had a critical need in order to keep a plant site operating. This company was very receptive to deploying new technology. The primary focus and need in that project was to identify relevant technology, provide appropriate training and give follow-up problem-solving assistance. In other companies that have received assistance it has been necessary to help the managers identify the need and importance for deploying new technology in their companies. Sometimes this takes six to twelve months to do. Once this phase has been accomplished the next phase of selecting the technology and providing appropriate training can be initiated.

It is apparent from reviewing the research studies and experiences of UW-Stout's Manufacturing Technology Transfer Center that the following factors/conditions are needed for successful transfer technology to small- and medium-size companies.

- A strong perceived need on the part of the company that new technology is required to remain competitive.
- Assistance in selecting the appropriate technology for the needs identified.
- Valid training to develop the knowledge, competencies and skills required to use the technology.
- In many instances the company's work climate and environment need to be changed. For example, the implementation of a computer-integrated manufacturing

system requires that the design, production, manufacturing, and marketing staffs work together.

2. Develop summary description of various approaches/models used by technology transfer centers.
3. Describe technology transfer models developed by various researchers and agencies.

In 1988 the National Institute for Science and Technology (NIST) conducted a study of state technology transfer programs. This study found that there were more than 200 organizations providing help and assistance to companies (Chapman, Clark, and Dobson, 1990, p. 43). The total funding identified for technology transfer activities was $620 million in 1988. The largest portion, 48 percent, was provided by state governments. The next largest portion was 26 percent from federal funds. Individual companies provided 12 percent and the university funds accounted for 9 percent. States in the south had the largest percentage of the expenditures, 35 percent (Chapman, Clark, and Dobson, 1990, p. 43).

Most of the assistance provided to manufacturers and businesses was focused on providing access to existing or off the shelf technology. This was 64 percent of the total assistance identified in the NIST survey (1990, p. 43). Access to new technology comprised 36 percent of the assistance.

The most common service provided by technology transfer agencies was technical assistance. This included providing technical information, evaluation of inventions, technical counseling, and information on obtaining patents. In the survey, 167 organizations reported that they provided technical assistance. In contrast, only 13 organizations said that they provided technology extension services (Chapman, Clark, and Dobson, 1990, p. 44). Technology extension services include direct consultation to manufacturers for technology deployment. These activities include needs assessments, on-site training and planning, and follow-up assistance with solving technical and human resource problems. Business assistance services, including financial analyses, management assistance and financial planning, were provided by most of the states.

The NIST report identified and studied the following types of technology transfer services.

- Business Assistance
- Incubators
- Research Parks

- Seed Capital
- Technology Assistance
- Technology/Research Centers

Business assistance includes providing information and advice on management, personnel, financial and legal matters. Incubators are facilities that provide laboratory and office space for new companies. In many instances there is an opportunity to share support services such as clerical, computer, and communications. Typically these services are provided at a below cost rate in order to facilitate the development of these companies.

Research parks are established to encourage interaction between private companies and universities. Seed capital provides funds to assist companies that are in their initial stages of development and cannot obtain money from the usual financial institutions. Research grants or R&D grants may be a part of this program.

Technology assistance includes providing technical information, patent information and more interactive outreach programs to assist companies in deploying new and off the shelf technologies. Technology/research centers usually focus their research studies in a particular discipline or area. For example, a research center might focus on biotechnology.

Technology transfer programs developed throughout the United States vary in scope and emphasis. Figure 2 presents a graphic description of typical components in technology transfer. The technology transfer programs studied by the researchers varied in their emphasis on various components in this system and the number of components included in their programs. For example, the Greater Minnesota Corporation (GMC) covers all of the components. Although it does not place a high level of emphasis on basic research, it does provide assistance to encourage researchers to license and patent their new knowledge and discoveries. The GMC program includes applied research institutes and technology research grants. The transfer of new technology will be stimulated through advanced manufacturing technology centers, seed capital programs, and business innovation/technology field offices. Proven technology will be transferred through the technology field offices and advanced manufacturing technology centers. The Indiana Corporation for Science and Technology focuses on the science and R&D end of the spectrum. It has targeted four specific fields and is encouraging research and development in these areas.

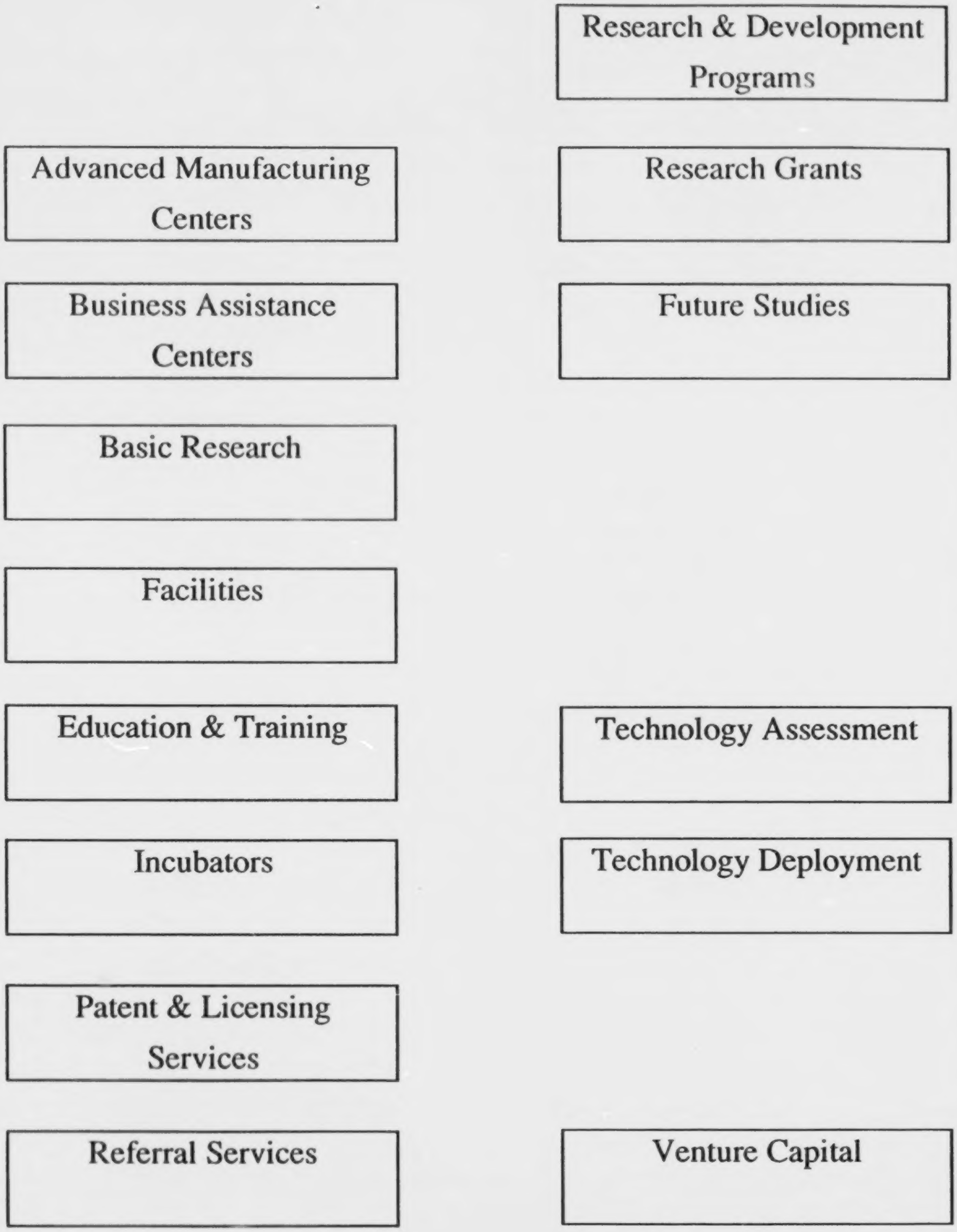

Research & Development Programs
Advanced Manufacturing Centers
Research Grants
Business Assistance Centers
Future Studies
Basic Research
Facilities
Education & Training
Technology Assessment
Incubators
Technology Deployment
Patent & Licensing Services
Referral Services
Venture Capital

Figure 2: Components of Technology Transfer

The Georgia Industrialization Extension Services provide assistance in the technology transfer and deployment areas. It provides information and technical assistance on new technologies, management techniques and planning. It also provides access to engineering problem solving expertise. Services are provided through a network of regional offices. Site visits are done to many of the firms requesting assistance in order to specifically identify needs.

The Michigan Industrial Technology Institute (ITI) includes R&D, technology transfer and technology deployment services. One of its major goals is the design and operation of the factory of the future. Services provided to companies include R&D, applications engineering, training, information services, evaluation and testing, and technical consulting. Most of its services in 1988 were in the process and product development areas. The Michigan Modernization Service (MMS) has become a part of ITI. It provides direct consultation to small- and medium-sized manufacturers. It usually does a needs assessment with a company that desires assistance. Based on this, it may provide technology deployment services, training, and/or market analysis. It has found that most of its clients need off-the-shelf or current technology. Each team for on-site visits includes a training specialist.

The New York State Industrial Innovation Extension Service (IIES) serves small manufacturing firms. Its objective is to improve their productivity through expanding and enhancing their technology. It has five regional offices and usually provides technical assistance with more efficient processes and assists with product development techniques. It provides broker assistance for management technologies and worker training. In other words, it refers companies to agencies, universities, and private companies that can provide this assistance.

The Ohio Technology Transfer Organization (OTTO) helps Ohio businesses access new technology and research. It participates in forecasting and identifying strategic manufacturing technologies that are important to the state of Ohio. It also assists Ohio firms apply these technologies. It provides engineering, R&D, and business management problem solving assistance to companies. There are 34 technology transfer agents housed at two year colleges throughout the state. It is primarily a brokering program helping companies that contact OTTO find agencies, universities, or other private companies that can assist with identifying and deploying appropriate technologies.

The Pennsylvania Department of Commerce and Penn State University jointly provide technical assistance through a program called PENNTAP. They provide services in the areas of scientific knowledge, technical problem solving, and technical information. Most of its assistance is focused on productivity improvement.

Another program that has implications for Wisconsin is the Machine Shop of the 90's developed by NIST. This program is concerned with developing and adapting technology that small machine shops can use. A small machine shop would be one with less than 50 employees. It is concerned with the following questions.

- What technologies are available?
- What technologies are affordable?
- How might these technologies be introduced effectively?

Its program of research and dissemination was developed through interaction with owners and operators of small machine shop and fabrication businesses. It has developed a computer integrated manufacturing system that can be adapted to small machine shops or job shops. The components of the system include cost estimating, process planning, tool room management, design, and manufacturing. Its disseminates this information through national and regional workshops and conferences. (Moll, 1990).

The technology transfer programs just described provide several approaches and emphases. Another dimension of these programs that needs to be explored is the type of interaction they have with their clients. Osborn has identified two categories of technology transfer programs. One is a passive type program that primarily provides brokering assistance in referring clients to other agencies that have the knowledge, technology, and/or the resources required. The second type of program is an active approach which involves a close and extended working relationship between the technology transfer agent and the company that needs assistance. Based on a study of technology transfer programs, Wyckoff and Tornatzky reported that active technology transfer programs were uniformly successful. In contrast the more passive types of programs that relied on referral services were not highly rated or regarded. Wyckoff and Tornatzky concluded that medium and small size companies often times lack the knowledge and technical expertise to identify and adopt appropriate technology. These companies need to have active assistance in this process. (1988, pp. 471-472).

An active technology transfer service is one in which a consultant or staff member performs a needs analysis on site, helps the company decide what to purchase, and assists it with the installation process. The assistance with the installation may include the design of the area in which the equipment will be located, training of employees, and follow-up trouble shooting.

UW-Stout's Manufacturing Technology Transfer program is an example of an active transfer process. Staff members visit the company that requests the assistance and identify its technology and management system needs. It assists the company in identifying the appropriate technology, training required and aids in arranging the training. Its staff members continue to work with the company until the technology and systems associated with it have been successfully deployed and the employees at the company feel at home using it.

The National Institute for Science and Technology (NIST) is also sponsoring four programs. These programs are regional centers for the transfer of manufacturing technology, industrial extension services program, advanced technology program, and a clearing house for state and local initiatives on productivity, technology, and innovation. These programs are described in more detail in the paragraphs that follow. The regional centers for the transfer of manufacturing technology are to disseminate modern automated manufacturing techniques to small- and medium-size companies. The regional centers will do the research and development required to make this transfer possible. The program of these Centers will include the automation of existing equipment, use of off-the-shelf technology, and application of technology that is priced within reach of these companies. The Centers will provide managers from business and industry with exposure to appropriate technology. They will also assist companies in selecting the proper technology for their needs and help them develop a linkage with a training institution for the training required. These Centers will be operated by NIST in partnership with non-profit organizations in states or regions.

The Industrial Extension Services Program is designed to expand the use of technology by small- and medium-size businesses. NIST will work with state and local extension organizations to disseminate this technology. Also, NIST will provide workshops and assist local extension agencies in gaining access to new technology and information.

Faster commercialization of scientific discoveries is the goal of the Advanced Technology Program. One of the thrusts is to make more extensive and better use of the federal research investment and the research activities which are generated by this investment.

The Clearinghouse for State and Local Initiatives on Productivity, Technology and Innovation collects data on state and local programs that promote technology development. It will identify programs and their impacts. Conferences and workshops will be conducted to share this information.

4. Isolate variables, services, and conditions that facilitate the effectiveness of technology transfer centers.

During the course of this study, information was gathered from a variety of sources. The general literature on the topic of technology transfer was reviewed, recent studies were carefully analyzed and site visits were made to promising locations. Based on this information, it was found that a wide variety of services are currently being provided by various states. In some cases services are unique to a given state. On the other hand there are some services that seem to be common and included in the objectives of technology transfer projects across the United States.

The primary purpose of technology transfer appears to be that of keeping the United States, individual states and localities within those states competitive in a world market. In doing this, many projects focus on keeping the business/industry climate healthy and on retaining, upgrading, and creating new jobs in the region served.

Employee training and development is a service that is offered by most technology transfer projects. This training is usually a combination of industry, technical institute, and university educational programs. Activities take place in the business/industry location, at technical colleges or on university campuses. The actual training is done by industry personnel, technical college instructors and university professors. In some instances, instruction is provided by equipment distributors and manufacturers. However, this instruction is usually organized by a user industry, technical college or a university.

Many projects conduct research in promising areas of development. Most research is conducted in some combination of effort by business, industry, government and education. Some of the research is basic and highly theoretical, while other is applied and more problem oriented. Although basic research is necessary in the long term, there appears to be an immediate need for applied research and the commercialization of the theoretical.

Although much of the research is focused on process and product, some projects focus on the future to determine where new opportunities will be emerging. This focus is aimed at enabling a state to position itself for future opportunities in the world market. The strategy provides for long term investment in the future and is proactive, whereas some of the efforts tend to focus on more immediate problems and a short-term future. Most of the transfer projects involved some form of technical assistance; however, in a few instances, projects also provided services such as linking those in need of venture capital with those who might be in the position to provide it.

Most technology transfer projects focus on assisting business and industry to solve various kinds of problems. In the process of solving problems, it is often necessary to first provide assistance with the definition and assessment of the problem. For example, industries will sometimes identify a problem that is very general; however, before assistance can be located and provided, it is necessary to first determine if that is the real problem. The second task is to narrow the problem to a specific point where it can be resolved. Assessment is usually accomplished through the use of an individual or small team working directly with the business or industry to specify the problem.

After the problem is defined, assistance can be identified to resolve the particular situation. Technology transfer itself is usually not involved in staffing to resolve specific problems; however, assistance is coordinated. This assistance might be available from individual consultants, other businesses or industries, a technical college, an equipment manufacturer, a supplier, a university, or some combination of individuals and organizations. In most cases, assistance involves in-plant, on the floor assistance with specific problems such as training, retrofitting, increased productivity and improved quality.

In some cases, a technology transfer project will have a limited number of staff persons who can provide specific technical assistance. However, in most instances the transfer process is that of connecting those in need of service with those who are in the position to provide services. As a result, the transfer staff is usually in a coordinating function and must be equipped to provide one-stop shopping for those who are searching for assistance. Many services are available and have always been available; however, in many instances it has not been possible for a busy business or industry person to be able to make a single phone call to access necessary assistance.

Because most technology transfer projects often serve a coordinating function, they are usually housed in a limited facility, adequate only to provide those services. As a result, most services are provided by other agencies that are connected with the various projects. Often the technology transfer function is housed in a technical college. With this kind of an arrangement many projects have found it useful and helpful to serve as a designated or authorized training center for vendors and manufacturers of various kinds of equipment. By being an authorized center, vendors and manufacturers bring equipment to the facility for purposes of training and as a result that equipment is made available for other education and training programs. Along with this, centers can function as demonstration facilities for vendors to use when they choose to bring potential clients to the facility for various demonstrations and other purposes. Instruction is provided by the manufacturer, vendor; or in some cases, by a specially trained instructor that is on the technical college staff.

It has already been pointed out that communication is a major function of any technology transfer process. However, in these examples, communication was in the form of connecting those in need of services with those who are in the position to provide those services. There are other communication functions in addition to making this linkage between needs and suppliers. Some of those functions include:

- Coordinating data bases from which information can be accessed readily.
- Wide area networks are also provided enabling those working on projects to communicate readily using a common communication network.
- Distant delivery of training is also being made available. These networks include voice, video, data and potentially satellite networking.
- Instructional materials are also being developed, such as printed forms, and videotapes.

Some technology transfer centers provide testing for new ideas. These ideas include new products and new processes. Often testing ideas provides technical college and university students and faculty with opportunities to become involved with industry problems. In these situations, students learn problem solving and new processes, faculty become upgraded and industry benefits from the improved idea.

Some technology transfer projects are largely reactive. That is, they position themselves to respond to problems that are brought to them. Other projects are reactive and also proactive in that they identify new and promising concepts and make those ideas available to business and industry. This is much like the agricultural county agent concept.

Some projects provide incubator facilities. That is, they provide a sheltered environment whereby a startup industry can locate and take advantage of technical assistance, clerical services and the physical surroundings. In all cases, there is a limit to how long a company can operate within the incubator environment. At some reasonable point, incubator clients must anticipate moving into the private sector. However, transfer services can still be provided.

Other services are also provided by different projects. Some of these include providing patent and licensing assistance, writing business plans and developing funding proposals.

Technology transfer services vary from state to state and project to project. The type of services provided will vary based on the nature of the businesses in the area and the priority of need. As new transfer projects evolve, each will need to assess regional and state needs so that appropriate services can be provided for those particular situations.

During the course of this study information was gathered from a variety of sources and presented to a technology transfer advisory committee. While many projects across the United States have different emphases, the committee recommended that for purposes of technology transfer in Wisconsin, technology be defined as a process of designing, making or doing something. Further, the goal is to provide quick response "shop floor" assistance to business and industry to deal with unique and specific problems of efficiency. Therefore activities should focus on human resource development and technology deployment.

Anticipated benefits from such a technology transfer process would include the following:

1. Existing jobs would be retained, others upgraded and new ones created.

2. The business/industry climate would remain healthy.

3. Educational programs would be improved through faculty and student participation with business and industry projects.

4. Relationships would be established so that when future opportunities became evident they could be addressed effectively.

5. Identify factors, approaches, and conditions that inhibit the effectiveness of technology transfer centers.

Wychoff and Tornatzky (1988) identified several factors that inhibit technology transfer in their survey study of fifteen state technology transfer programs. Their study focused on transfer to manufacturing companies. They found that staff with appropriate competencies and experiences were hard to recruit and retain.

Competent staff were often lured away from the technology transfer center by the companies they had helped. Utilizing university and technical college staff also had problems associated with it. Technology transfer activities do not have the same time schedule, pay-offs, and reinforcers as typical activities in the educational setting. Many faculty members are reluctant to leave their classrooms and laboratories for the uncertainties of the factory setting.

The researchers also reported that technology transfer programs found that it was hard to keep up-to-date with changing technology and to be able to respond to a diverse set of requests. Also, these projects reported that it was a challenge to balance active assistance with brokering activities. Both were viewed as important to a successful program.

Another important factor that constrains these programs is funding. Most programs are funded primarily by state and federal allocations. In periods of recession, when the programs have a higher demand, funding is often reduced or held constant.

Wychoff and Tornatzky also found that these programs usually did not concern themselves with the social and human resource development aspects of technological change. These changes often have a marked effect on organizational climate and the competencies needed by various groups of employees. Another deficiency area was evaluation. The programs surveyed reported few formal evaluation programs or activities.

Criteria for the Development of a Technology Transfer Process. The following criteria were developed based on the research of the project staff and the recommendations of the project's advisory committee. Technology transfer should:

1. Serve a wide-range of Wisconsin business, industry, education and government needs.
2. Provide easy access to a coordinated state and national network of information and services.
3. Provide, at the work-site, technology deployment services.
4. Emphasize practical, "one stop shopping" for clients without frustrating referrals.
5. Serve clients of all sizes; however, small- and medium-size firms tend to be in greatest need.
6. Provide a means by which entrepreneurs and innovators can receive services.
7. Provide service at the local level.
8. Focus on the deployment of existing technology and the development of personnel to work with that technology.
9. Be proactive as well as reactive. Ask prospective clients what they need, but also make proposals that could be in their best interest-technology "push and pull."
10. Serve a manageable number of clients and serve them well. Don't evaluate only on "nose count," measure quality of service.

6. Determine the resources needed to support an effective technology transfer system.

The discussion related to this objective will primarily focus on the costs reported by various technology transfer organizations. The information for this will be based on the NIST report (Chapman, Clark, and Dobson, 1990). A detailed cost estimate for the technology transfer system proposed for Wisconsin is included in the discussion for objective nine.

The cost per client or firm served ranged from $500 to $143,000. These figures are based on 1988 budgets. The technology transfer organizations that emphasized brokering and referral services averaged about $1,100 per client during the 1988 year. These programs include providing technical information to clients, directing them to organizations that could provide more indepth help and some assistance with needs identification.

The cost per client in the active technology transfer programs ranged form $18,000 to over $100,000 per client. An active program includes going on-site and working with a company for an extended period of time. Michigan Modernization Service (MMS), which is a part of the Michigan Industrial Technology Institute, reported an average client cost of approximately $18,000 per client during the 1988 year. The program of MMS focused on technology deployment and information dissemination. The program of the Michigan Industrial Technology Institute (ITI) included some R&D work and about ten percent of its activities were focused on product and process commercialization. Product and process commercializations would include activities that move a new technical development into the manufacturing state. The average cost for ITI was about $83,000 per client.

Pennsylvania initiated a new program in 1988 entitled Pennsylvania Industrial Resource Centers Program (IRC). The program was funded with ten million dollars of state money per year for a three-year period. The goal was to serve 30-70 firms annually. Using the 70 firm target, the average cost per client would be approximately $143,000 per client. The purpose of the IRC was to transfer both off-the-shelf and advanced technology to small- and medium-sized firms. The centers are not university based and will thus probably incur some facility costs. The IRC program includes adapting and linking computers to manufacturing processes, improving quality programs and advanced production planning techniques. One component of the program includes training for workers in the client companies.

The cost data reveal a wide variety of per client costs. It is relatively inexpensive to provide brokering and referral services. Unfortunately, research evidence indicates that these services are minimally effective. This is especially true for small- and medium-sized companies that do not have a lot of engineering and technical expertise. These companies need to have long-term assistance with selecting and deploying new technology. The expensive programs are ones that have an active approach to technology transfer. They do needs assessments for their clients, assist in selecting an appropriate technology, help them plan a training program for their employees, and work with the client company until the technology has been completely deployed and is understood by workers and management.

The NIST study (1990) did a detailed analysis of 13 technology extension programs. The study found that the staff size ranged from one person to one hundred twenty-two. The average staff size was 20. In those instances in which a center had multiple staff members, there was usually a blend of technology/engineering and business oriented expertise (Chapman, Clarke, Dobson, 1990, p. 63).

7. Develop a minimum of three technology transfer models that could be used by the Wisconsin VTAE system.

Potential technology transfer models for the Wisconsin VTAE system can be differentiated on three factors; (1) scope, (2) level of involvement, and (3) partners. The scope of the model relates to the range of activities that would be undertaken by the VTAE technology transfer center. The technology transfer programs reviewed in previous sections of this report reveal a wide range of activities. For example, the Greater Minnesota Corporation program includes research and development through technology deployment. This model has a wide variety of sub programs within it. On the other end of the spectrum, some technology programs focus primarily on the deployment of proven or off-the-shelf technology. The Ohio program emphasizes this approach.

Involvement relates to the extent to which staff members of the technology transfer centers would work directly with clients. At one end of this continuum are the centers that act as brokers or referral agencies. Clients who contact these centers are referred to other people and organizations for assistance. Active programs that go out on-site and identify the clients' needs, help select appropriate technology, and stay until the company has fully deployed the technology are at the other end of this continuum. As discussed previously, the active approach has proven to be more successful in transferring technology into small- and middle-sized companies.

The partnership dimension is concerned with the various agencies that will work together in the technology transfer program to provide the services needed by business and industry. The VTAE system and individual technical college districts could provide their own technology transfer services either individually or through a consortium of districts. On the other end of this continuum would be a partnership that includes several VTAE districts, VTAE System, and a university. This partnership could also be expanded by involving other agencies and organizations that are concerned with technology transfer and economic development. Osborn noted in his report that technology transfer is a complex activity and needs a variety of players and a network of resource people and agencies.

A review of the findings in the NIST survey and discussions with staff members at NIST indicated that significant impacts could be made by transferring proven or off-the-shelf technology to small- and medium-sized companies. In many instances, larger companies have their own R&D and process development units which keep them up-to-date with new technology.

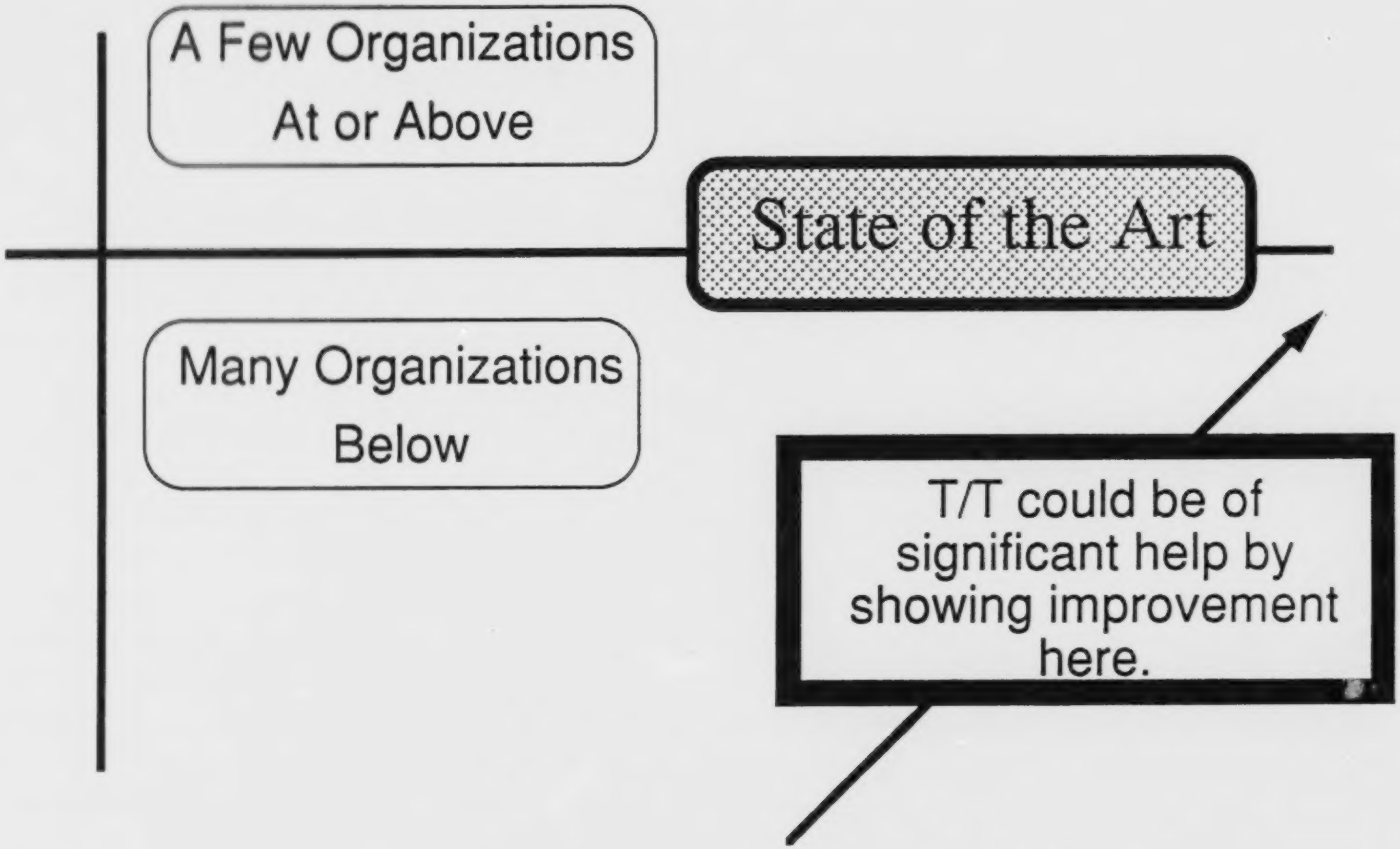
However, a large majority of our manufacturing is done by medium- and small-sized companies, and thus there is a significant need to assist them. Figure 3 presents a graphic illustration of this need. Several of the state technology transfer organizations reported in the NIST survey that 70 to 90 percent of their work was in transferring proven technology to small- and medium-sized companies. The experience of staff members in UW-Stout's Manufacturing Technology Transfer Center confirms that this situation also exists in Wisconsin.

The relationship between science, technology and innovation is given in Figure 4. Science develops new knowledge and conceptual systems. Technology is concerned with applying knowledge and tools to solve practical problems. Technology draws some of its knowledge base from science. However, technologists also create some of their own knowledge and skills as they work on practical problems.

The S curve placed on top of the technology block reflects the usual dissemination of new technology. Innovators are the first to adopt and use a new technology. After the innovators have had some success, early adoptors pick up the technology and apply it to their needs. Once the early adoptors have proven that the technology can be used a variety of settings, many other companies follow suit. Laggards are found in the last stage. These are the companies and individuals that hold off until they absolutely must change in order to remain competitive. In some instances, they wait too long and are unable to remain competitive and stay in business.

Using the three dimensions described in the first part of this section and the conceptual structure presented in Figure 4, one can identify several different models for technology transfer that are in place and being used. These are discussed in more detail below.

Generate scientific knowledge. This model focuses on targeting certain areas that have potential for economic development and encouraging scientific research in the area or areas. This encouragement could be through direct funding to universities, research grants to



A Few Organizations At or Above

State of the Art

Many Organizations Below

T/T could be of significant help by showing improvement here.

Figure 3: Technology Transfer to Attain State-of-the-Art

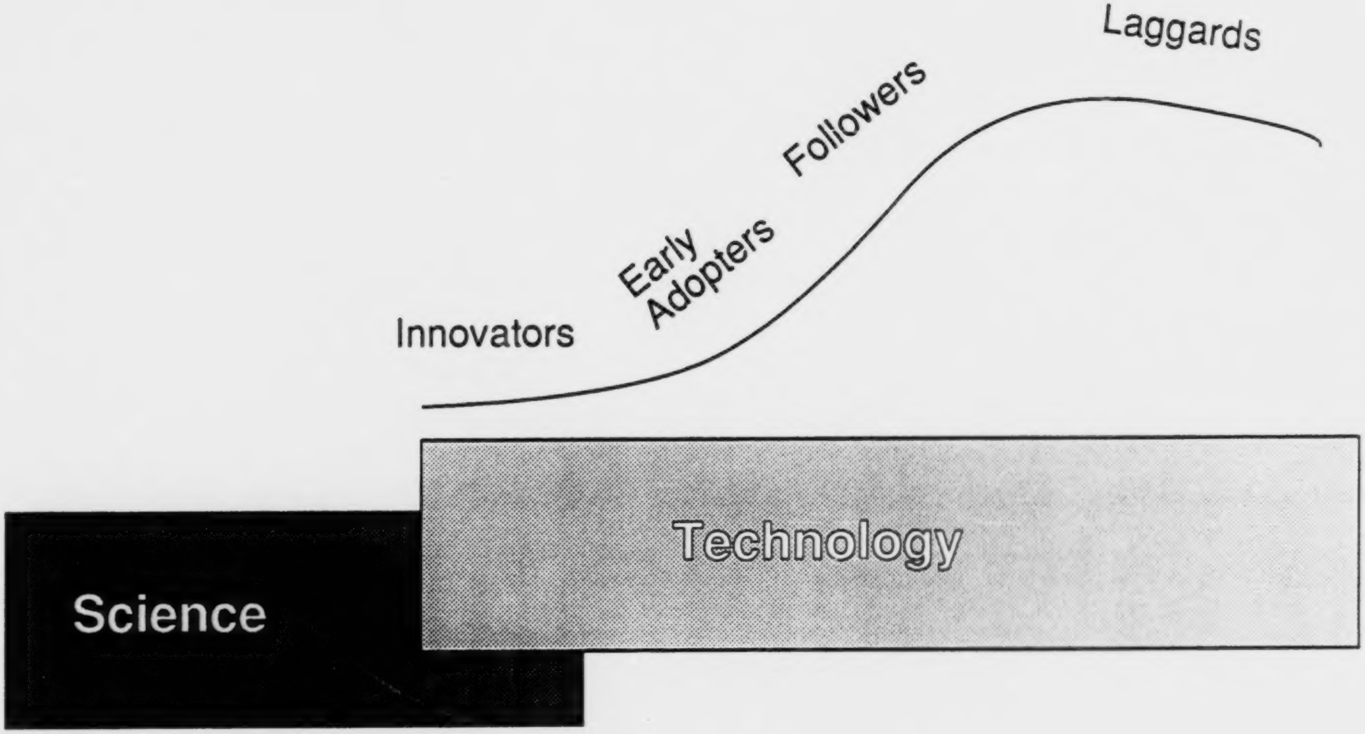

Laggards
Followers
Early Adopters
Innovators
Technology
Science

Figure 4: Science, Technology and Adoption Linkages

individual researchers, and/or research grant programs open to public and private institutions. The Indiana Corporation for Science and Technology is an example of this model. Also, the Greater Minnesota Corporation includes a program on this end of the spectrum as a part of its total program.

Technology innovation. Another model is one that emphasizes the commercialization of new scientific developments. It focuses on the interface between science and technology. For example, the Greater Minnesota Corporation has several applied research institutes that work in this area. Also the Michigan Industrial Technology Institute has a component of its program that emphasizes the commercialization of scientific developments in the area of advanced manufacturing techniques.

Technology deployment. Another potential model is one that emphasizes technology deployment through which companies are assisted to use proven technology. Several of the state models include this emphasis. Those state organizations that use the industrial extension service approach fall in this area.

Active versus passive involvement with clients. Another dimension a technology transfer model will need to consider is the approach it will take with its clients. A passive approach is one in which clients are referred to other agencies for assistance and the technology transfer center becomes a broker in this process. An active approach is one in which members of the technology transfer center staff go on-site and actively assist a company to identify appropriate technology and then work with the company's employees to put this technology in place.

Partners. A variety of configurations exist in the technology transfer operations studied. Almost all the technology transfer programs included partnerships that involve several agencies. All of the technology transfer programs had at least one permanent staff member. Other partners identified included university staff, technical college staff, federal government agencies and bureaus, state agencies and local agencies/organizations concerned with economic development. None of the literature reviewed or interviews conducted suggested that an individual or solo approach would be the most effective.

Advisory committee recommendations. During the June meeting of the project's advisory committee, the information collected by the project researchers was reviewed. The technology transfer framework and the various components of the framework were presented and discussed. Based on this information and their previous knowledge of technology transfer, the committee members recommended that:

- the Wisconsin VTAE model should focus on technology deployment.
- the approach or type of involvement should be active in nature. This does not preclude offering referral assistance and information to clients. However, the technology transfer center staff must be equipped to do indepth work with clients.
- the technology transfer model should include the opportunity to involve a variety of partners in delivering services. Advisory committee members recommended that there be an opportunity for VTAE districts, university campuses, local agencies and state-level agencies to work together to provide the assistance and resources needed for technology transfer.

The primary focus on technology deployment is depicted in Figure 5. Advisory committee members recommended that the technology transfer model emphasize using an active approach to assist companies in accessing and deploying technology that would improve productivity in their companies. This would involve needs assessment, assistance with selecting appropriate technology, training, and follow-up assistance to see that the technology was adequately deployed. Components found in other programs such as future studies, technology conferences, etc., would be potential activities as they relate to the overall goal of technology deployment. For example, some of these activities, such as having a local advisory committee to monitor needs and a futures study committee to identify trends and changes in technology that need to be disseminated to area business and industry would be appropriate. Also conferences that expose owners and managers to technology that could improve productivity in their companies would be helpful and might be a first step to working with a company to deploy new technology. Other components such as seed money and research grants may not be particularly appropriate. However, the center staff members and the participating agencies could encourage others to provide these services. All of these components form a support system that is the basis for technology transfer and economic development. However, it was the recommendation of the advisory committee that the Wisconsin VTAE technology transfer program focus on technology deployment. The research reported in this study confirms the importance of this thrust and identifies it as a major need.

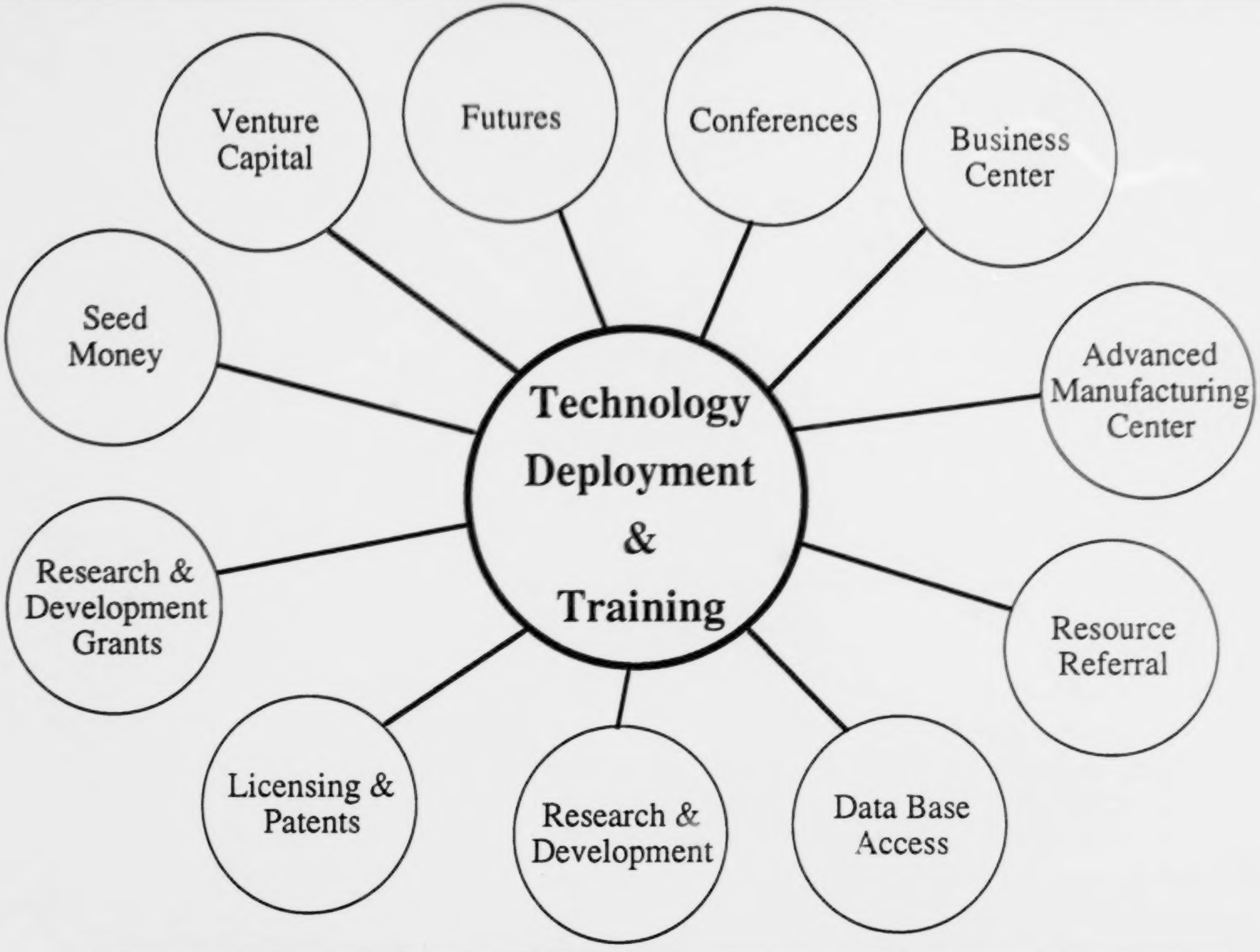

Technology Deployment & Training
Venture Capital
Futures
Conferences
Business Center
Seed Money
Advanced Manufacturing Center
Research & Development Grants
Resource Referral
Licensing & Patents
Research & Development
Data Base Access

Figure 5: Technology Transfer Components — Focus on Deployment and Training

8. Develop a plan for a technology transfer system for Wisconsin that includes integral roles for the Wisconsin VTAE System and UW-Stout

An Introduction to the Proposed Model

Some organizations in the United States are operating at the state of the art. That is, they are employing technology that positions them in a very competitive advantage in the world economy. Many organizations; however, are functioning at some distance below that of optimum capability and some are significantly below the state of the art. Technology transfer could be of significant help by assisting organizations to move from whatever position they find themselves to a position closer to a position of competitive "know how." (See Figure 3 on page 24.)

Many organizations and agencies are available to provide assistance. However, in many cases, companies particularly those that are small and medium sized, often find it difficult to locate the kind of assistance that is necessary for their specific needs. This is especially true with innovators and entrepreneurs. Often they work individually and have little or no concept of how help might be obtained.

Technical colleges and universities are uniquely positioned to participate in technology transfer. They have expertise and facilities. Industry and business encounter problems that are based on factors of global market dynamics, rate of societal change, industrial development in emerging nations, and significant technological breakthroughs, to mention a few. Universities tend to be bureaucratic organizations aimed at steady improvement, however, they are often not positioned to be responsive on short-term demand. Technical colleges are positioned to be somewhat more responsive than universities; however, they too are better positioned for long-term improvement and responsiveness. Because universities and technical colleges are geared to provide long-term services, and business and industry is being impacted by everyday changes, a gap exists between services needed and those that are able to be provided by educational institutions. Thus, the apparent and obvious need for the function of technology transfer. (Figure 6)

Technology transfer, therefore, is aimed at taking into account the rapidly changing needs of business and industry, and linking it with the resources and capabilities of universities, technical colleges and a host of other resources that are available to provide services. Transfer,

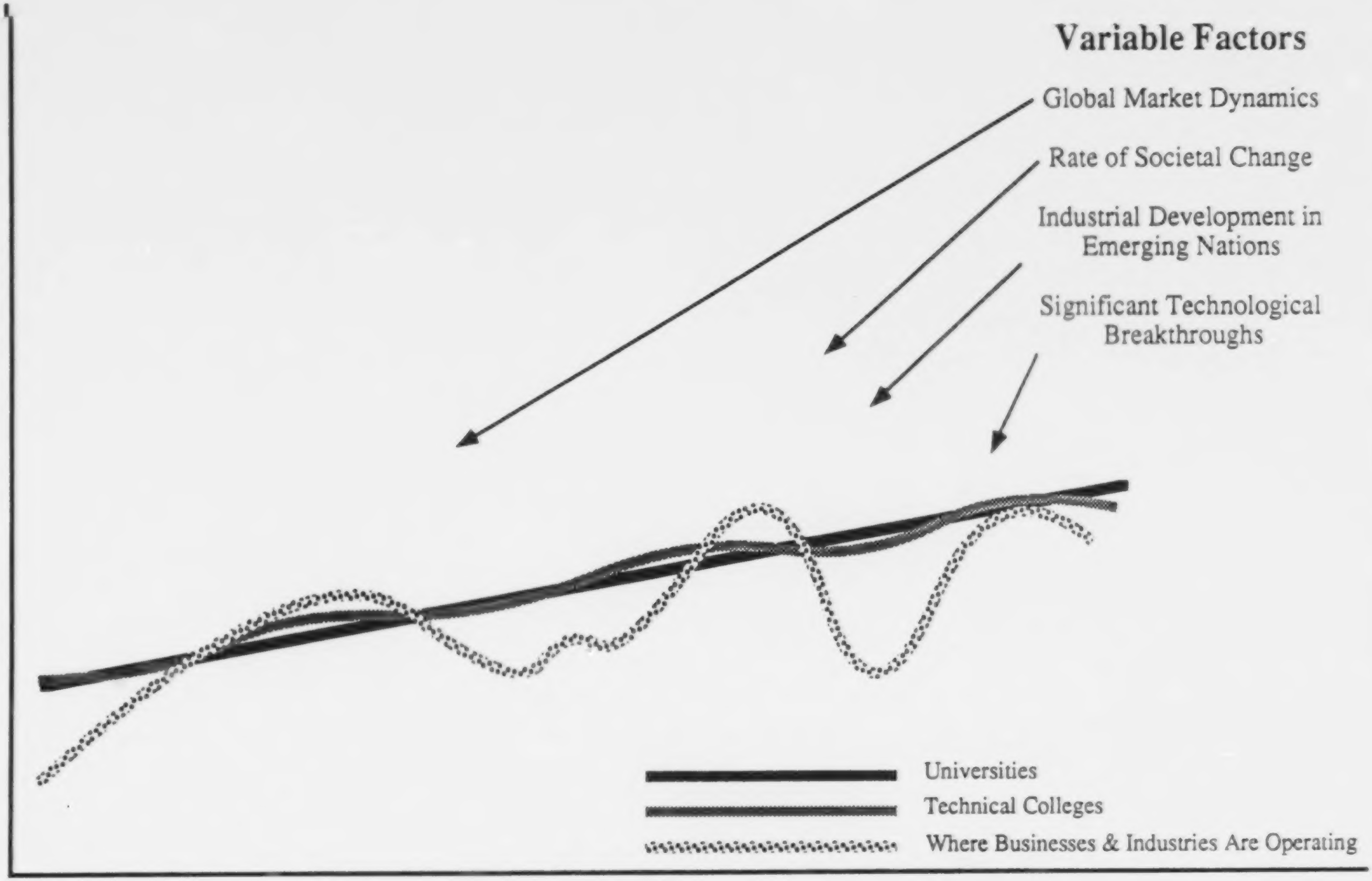


Figure 6: Value of Technology Transfer

therefore, is not a duplication of services, it is primarily a coordination of services for rapidly developing needs.

Universities and technical colleges will be called upon to provide unique services both as institutions and as individuals within those organizations. As a resource; however, these institutions will be coordinated by the technology transfer process. That is not to say, however, that they cannot continue to operate as they have been as resources to business and industry. This would also hold true for other service providers in the state of Wisconsin. They will continue to serve in the capacity they currently serve; however, they will also be drawn upon as resources as technology transfer needs dictate.

A Concept Model

The purpose of technology transfer is to apply new and existing technology in business and industry situations so that we as a nation, and more specifically the state of Wisconsin, can compete in the world economy. This goal requires that we work together cooperatively, both as individuals and as organizations. However, working together is often difficult without some formal process to facilitate the cooperation.

Business and industry in Wisconsin have many problems to overcome as they strive to improve quality and productivity. On the other hand, there are many organizations and agencies in a position to offer assistance. The difficulty comes in matching up those who are in need of services with those who are in the position to provide services. Thus, there is a need for some coordinated process of facilitating this much needed match up.

As organizations identify problems, they experience difficulty getting to the most appropriate individual or organization to help solve the problem. In the process they are often referred from one agency to another, and as a result, end up with unnecessary frustration. Therefore, the technology transfer process must provide one-stop shopping. That is, establish one point of contact from which many services can be coordinated. When individuals or organizations, regardless of size, experiences a problem, they should be able to make one phone call or write one letter to gain access to the services that could ultimately resolve the problem.

To be of maximum service, the process of technology transfer should clearly define the services that can be provided, and how a person or organization might access those services. Following is a technology transfer process model (Figure 7) which describes the relationship between services requested, resources and projected outcomes.

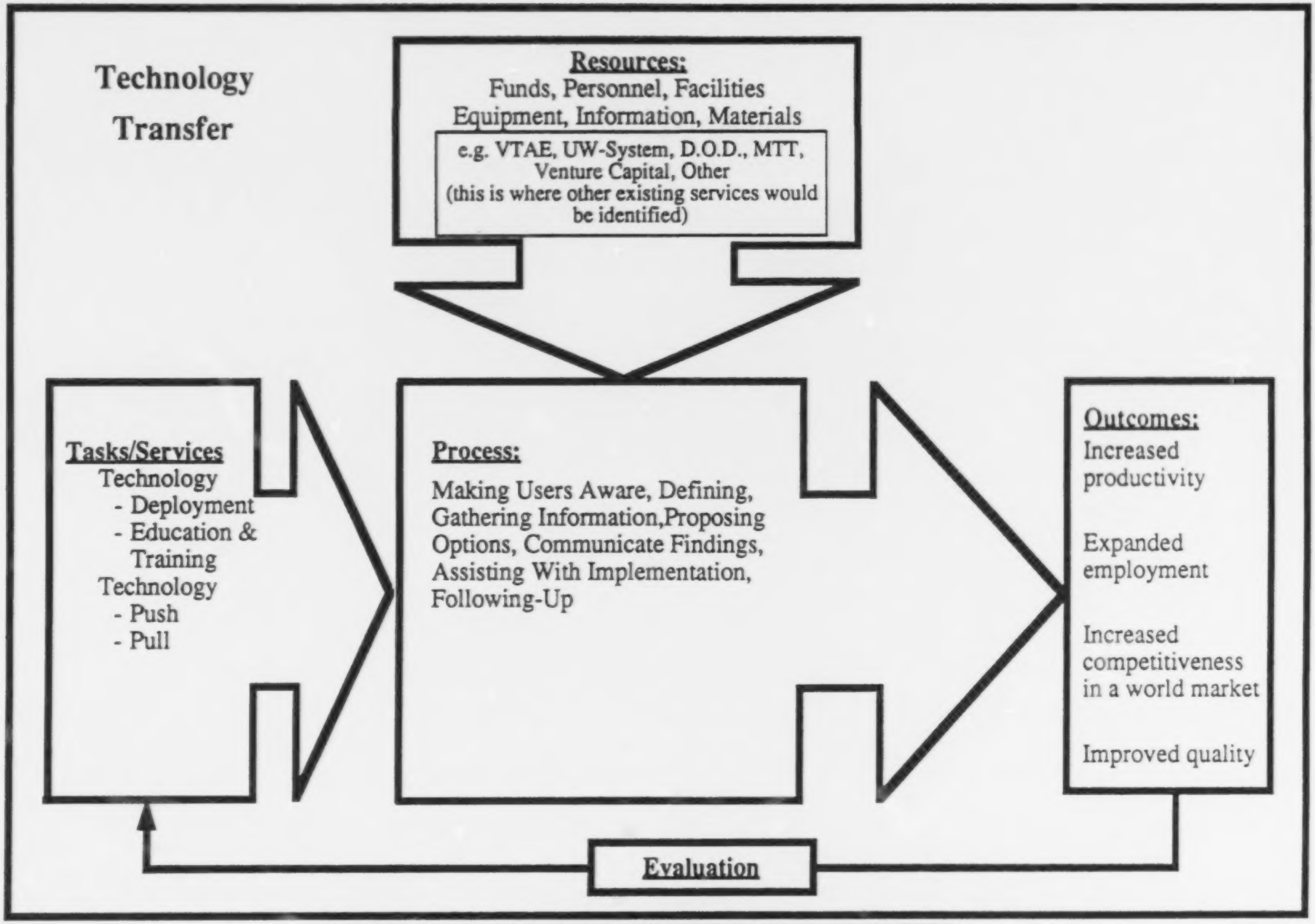

Technology
Transfer
Resources:
Funds, Personnel, Facilities
Equipment, Information, Materials
e.g. VTAE, UW-System, D.O.D., MTT,
Venture Capital, Other
(this is where other existing services would be identified)
Tasks/Services
Technology
- Deployment
- Education & Training
Technology
- Push
- Pull
Process:
Making Users Aware, Defining, Gathering Information, Proposing Options, Communicate Findings, Assisting With Implementation, Following-Up
Outcomes:
Increased productivity
Expanded employment
Increased competitiveness in a world market
Improved quality
Evaluation

Figure 7: Technology Transfer Process Model

Process Inputs

The input side of the process model suggests some of the services that might be provided to business and industry. Often these services are categorized into technology pull and technology push. Technology pull is when an organization requests a service. Technology push, on the other hand, is when a service is made available, even though a request has not been made.

Technology pull could be described as a situation where a business/industry organization has a specific problem and is seeking a solution. In this instance, a request would be made to a specific location designated as the starting point for all statewide transfer activity. That single contact would give the requesting organization coordinated access to a vast part of state and national resources. Matching a problem with appropriate resources is an important step in solving a problem.

In the case of technology push, a potential or capability might be made available to area business and industry even though they have not made a request. A common example of push technology is the concept of a county agricultural agent. Agents, for example, seek out new technology and management procedures in agriculture and make that information available to area farmers. Individual farmers can then make a decision about whether or not they believe the new development is worth incorporating into their respective operations.

A technology transfer process could provide both pull and push services for Wisconsin business and industry. Some services might include assistance such as (1) generating new business, (2) developing a skilled work force, (3) integrating new and existing technology, (4) developing on-the-job training and personnel development, (5) gathering information, (6) providing a demonstration facility to experiment with new technology, (7) developing communication linkages with other organizations, (8) helping to retrofit an operation, (9) accessing consulting help, (10) developing business plans, and (11) coordinating existing services.

Based on the wide variety of services that could be provided, decisions will need to be made about which services fit within the definition of technology transfer. When a request comes from a business or industry the next task would be to begin the process of resolving the problem or satisfying the request. This activity would fall with the "process" section of the transfer model.

Process

The process segment of the model is the area where the technology transfer activity actually takes place. One function of the process is that of making potential clients aware that services are available. This awareness would include, information about services and how to access those services. It will be important to keep the process simple. Clients are often confused and frustrated when they are referred to other sources or provided with insufficient information. As a result, in the awareness phase, it will be important to provide specific information, and to keep it concise and understandable.

When requests are made for services it will usually be necessary to help the client specifically define the problem. Often times, a client might think they know the real problem, however, after careful analysis it might be determined that the actual problem is something different from the perceived problem. Therefore, it will probably be necessary to assemble an assessment team to visit with a prospective client to help define the problem in manageable terms.

In the process stage it will also be necessary to draw upon a variety of resources to assist clients with defining problems and with gathering appropriate information to help resolve the problem. This state of the process will include accessing information from libraries, data bases, other organizations, agencies and resource persons. The information will need to be sorted to determine that which will be most useful to the solution of the problem. The information would then be organized and stated in understandable, concise, and manageable terms. This raw information will probably not be given to the client, instead it would be more appropriate to propose possib[illegible]tions for consideration.

From the information gathering process it will usually be evident that different options might be appropriate. As a result, a set of possible solutions could be drafted for consideration by the client. These possible solutions would be complete with both advantages and disadvantages. It would be appropriate to identify a recommended or most promising solution along with a rationale for why this option might be the best way to resolve the problem. It is going to be important that information be related directly back to the specific problem that was originally identified by the assessment team.

After a client has had an opportunity to study the proposals and make a decision, then the next phase of the process would be that of connecting the client with the resources that would be most appropriate to solving the problem. The resources are varied; they include: funding, personnel, facilities, information equipment, and materials. These resources are often housed in different organizations and agencies. As a result, in the implementation phase, it will be important that the most appropriate resource agencies be contacted and coordinated to provide the services necessary to resolve the problem. This function, however, must be more than just a simple brokering process. Although it is important to link the person or organization in need of service with those in a position to provide service, it is essential that some kind of follow-up be maintained to ensure that the service was actually provided.

In some companies an active technology transfer process will be needed. This will require a team of technology transfer specialists who work in the company to help adapt technology to the company's needs, train employees, fully implement the technology, and assess the impacts of the changes made. This capability must be available through the technology transfer process.

The technology transfer process will need to provide a follow-up or monitoring service that will ensure that the process was effective, the client received satisfactory services, and that the problem originally identified was, in fact, resolved. The process will not succeed unless there is thorough follow through from the identification of the problem through the final solution.

Resources

Although a technology transfer process is being proposed for the state of Wisconsin, this does not imply that resources are not already available and being provided by agencies that currently exist for such a purpose. The problem lies in that these agencies are not coordinated to provide service on a readily accessible basis to prospective clients. Some of these organizations include: government agencies, such as the Department of Development; educational institutions, including the Vocational, Technical and Adult Education System; and the University of Wisconsin System, University Extension; federal agencies; other businesses and industries with particular and unique expertise. Individuals working independently from an agency, and others that might not be easily categorized into any of the organizations just mentioned. Functionally, some of the agencies mentioned might very well continue to provide services as they currently do. However, a technology transfer process will serve to better connect prospective clients with these agencies.

The resources that exist and the agencies that provide those resources, offer a wide variety of potential services. Some of these services include those listed below. Some however, may not be consistent with our definition of technology and the mission of technology transfer.

- Creating a climate for economic development
- Generating new business and industry by providing incentives
- Developing a uniquely skilled work force by providing pre-employment training and on-the-job training
- Integrating new technological capability into existing operations
- Interpreting new development such as technology management techniques, global markets and future directions
- Planning a most desirable technological economic and competitive future for the state of Wisconsin
- Developing new technology and systems
- Providing facilities for manufacturers and vendors to display new technology
- Assessing individual and organizational skill capabilities
- Developing unique instruction for a variety of learners
- Locating new and promising developments that can be brought to industry application
- Developing designated training centers for equipment manufacturers
- Assist with industry retrofitting
- Providing consulting assistance
- Assisting with business planning
- Negotiating funding and financing
- Synthesizing information into concise and understandable terms
- Promoting Wisconsin-its products, services, people and quality of life

Outcomes

Clients will gain from the technology transfer process in that they will have many of their problems resolved. This, in turn, will put them in a more competitive position in the world market. Residents of the state of Wisconsin will benefit as well because many existing jobs will be maintained, others will be upgraded, and new ones will be created. A healthy business/industry environment and the availability of good jobs results in an improved standard of living for everyone. As a result, everyone benefits.

Other benefits include:

- Upgrading of university, technical college and high school staff through working with business and industry

- Expanded learning opportunities for students through involvement in projects and indirectly from having their teachers involved
- Improved working relationships between business, industry, education and government
- Shared information that multiplies benefits
- Demonstrated ability to share services and resources

State and Regional Centers

The project's advisory committee recommended that two or three pilot regional centers be developed to provide technology transfer assistance. These centers would be coordinated from a state-level office.

The state-level functions would include coordinating the work of the regional centers, networking with state agencies and organizations, and evaluating the impacts of the statewide technology transfer program. The state-level office would also serve as a central contact point for business, industry, and education. It will be a contact point for companies, agencies and individuals outside of the state who are interested in Wisconsin's technology transfer program.

This office will develop the annual and biennial budgets needed to provide funding for the state-level and the regional centers. It would also prepare proposals for federal, state and private funds.

Another function of the state office will be to disseminate information on the technology transfer program and how business, industry, and entrepreneurs can access and use its services. It would prepare reports periodically on the types of projects being carried out in business and industry. Also, it would report the impacts of various projects conducted.

The state-level office would be the primary access channel to external data bases. As requests are received at the regional centers, they would be forwarded to the state-level office if a search of an external data base is needed. This would reduce the cost of this activity and allow one or two people to specialize in this area.

The state-level administrative office and regional centers are depicted in Figure 8. Committee members recommended that regional centers be placed so that they serve different geographic regions of the state. They further suggested that the centers be assigned on the basis of proposals submitted by the VTAE districts, university campuses, or combinations thereof.

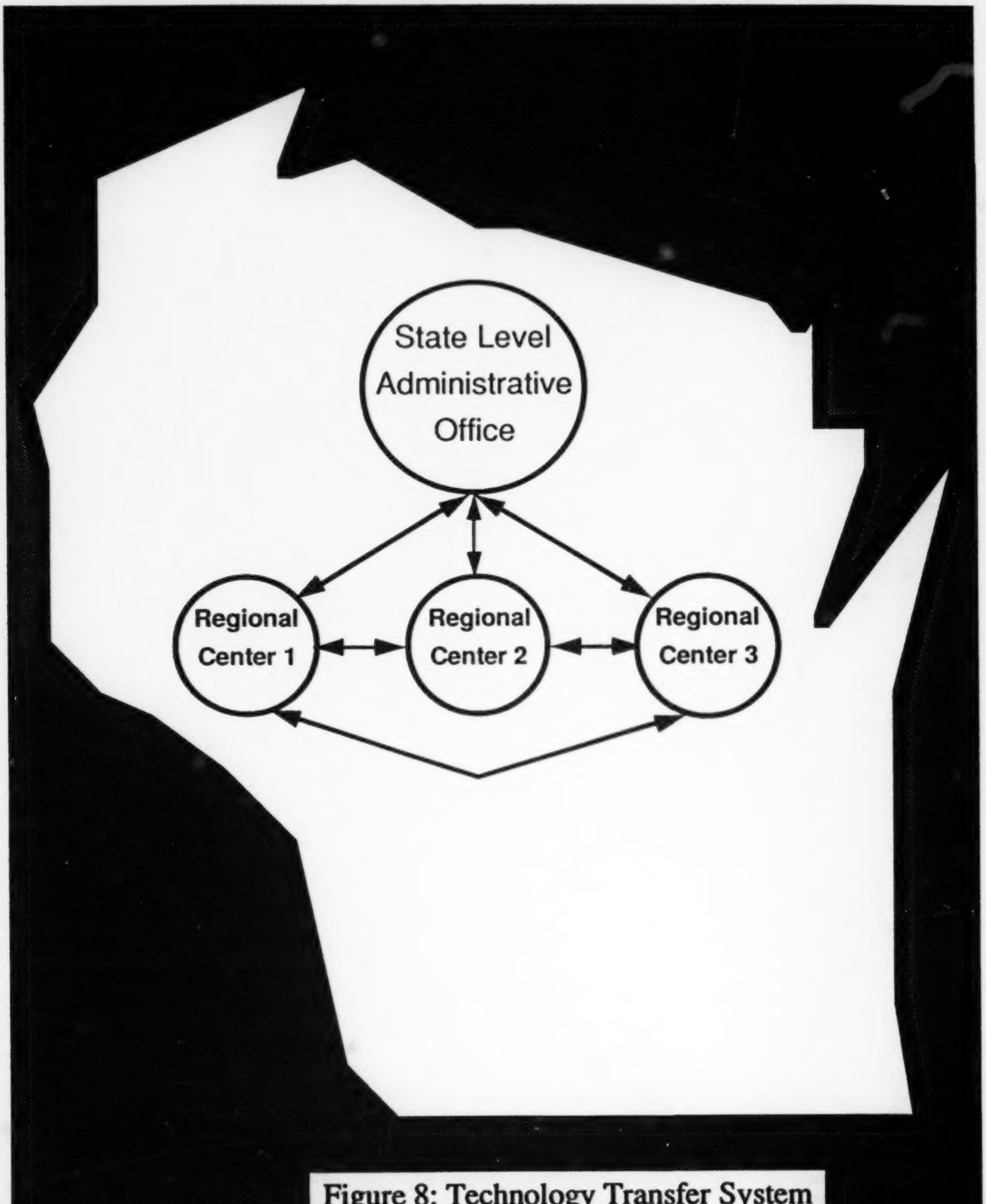

State Level Administrative Office
Regional Center 1
Regional Center 2
Regional Center 3

Figure 8: Technology Transfer System

Regional Technology Transfer Centers

The regional centers will specialize in one or more areas based on the needs of the geographic region served. In addition, the regional centers will provide many similar services since companies in various parts of the state have similar needs. (Figure 9)

Purposes

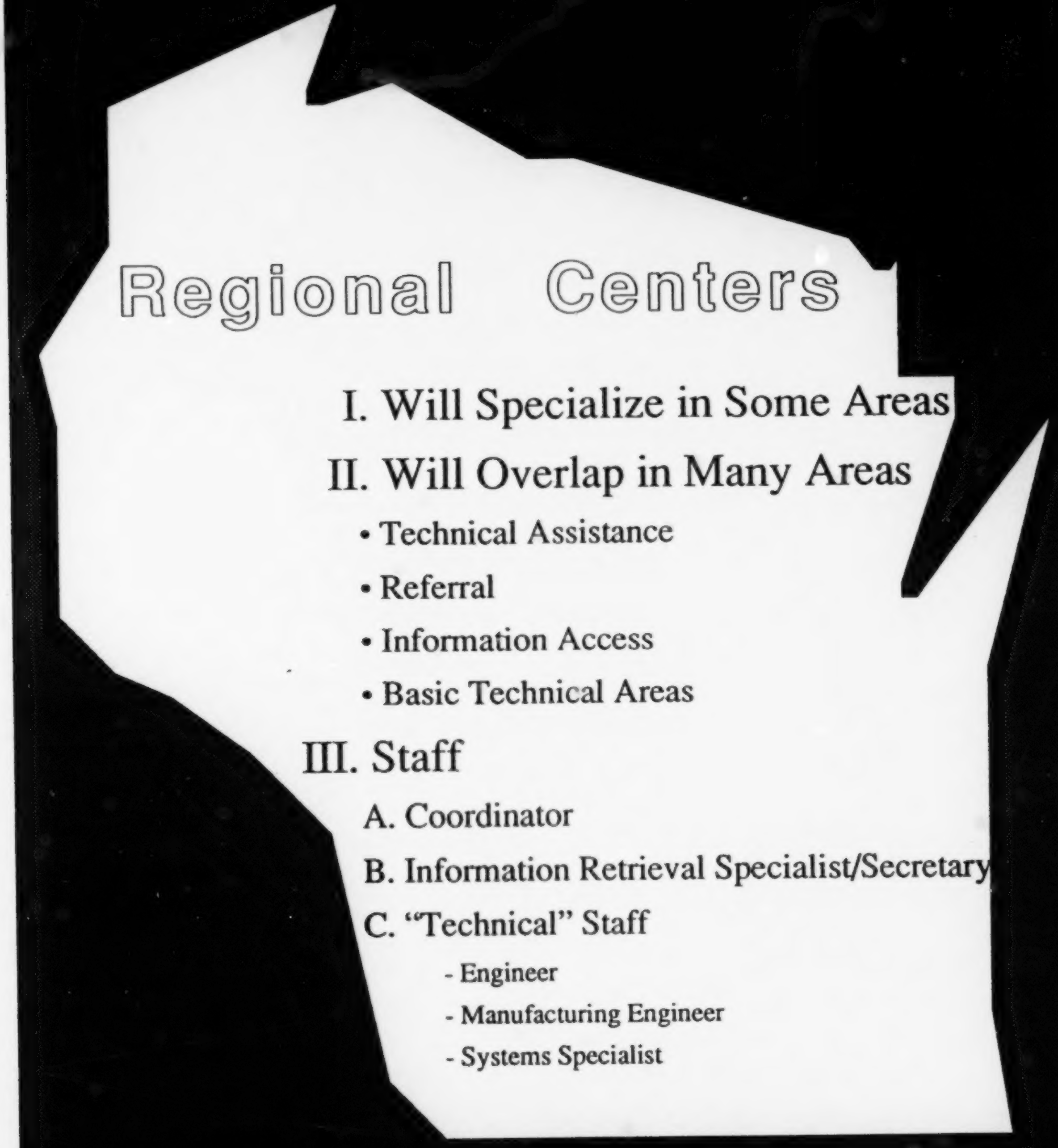
The Regional Centers will be designed to accomplish several purposes. These purposes will include:

- Conduct active technology deployment and training projects
- Provide short term technical assistance to companies and entrepreneurs
- Give access to technical information needed by companies
- Refer potential clients to organizations, agencies, and/or individuals who can assist in resolving the company's needs
- Conduct conferences, demonstrations and other activities that will expose companies and organizations to new technology
- Evaluate the technology transfer activities initiated and conduct research on various approaches to technology transfer and deployment.
- Provide an avenue for the technical update of VTAE and UW System instructors
- Identify competencies that should be addressed in university, technical college and high school curriculums

Staff

The regular staff members assigned to each regional center will include a coordinator, retrieval specialist/secretary, and two or three technical staff members. The coordinator will be responsible for the overall operation of the Center and communications with the state office. The coordinator will also have primary responsibility for the public relations and dissemination activities carried out by the regional center. In addition, the coordinator must be a specialist in the needs assessment area.

The information retrieval specialist/secretary will be the initial contact for most people who contact the Center. Thus, it is important that this individual be knowledgeable of the resources



Regional Centers

I. Will Specialize in Some Areas

II. Will Overlap in Many Areas

- Technical Assistance
- Referral
- Information Access
- Basic Technical Areas

III. Staff

A. Coordinator

B. Information Retrieval Specialist/Secretary

C. "Technical" Staff

- Engineer
- Manufacturing Engineer
- Systems Specialist

Figure 9: Regional Center Resources

available in the Center, as well as, within the participating institutions. This will be the only staff member who will probably be in the office most of the day. The other staff members will be working out with business and industry in the region, or visiting with technical college and university staff members. This individual will be able to operate the information retrieval systems available in the regional center and be able to refer requests to the state level office. In some instances it will also be necessary to involve the coordinator and/or technical staff members to further clarify the problem presented by a caller.

Technical staff members will have an expertise in areas such as engineering, design, manufacturing engineering, and production systems. They will be able to assist companies with installation of new production systems. They will also be able to assist clients in improving existing systems.

Staff members involved form the critical mass required to carry out the activities of the Center. They are the more permanent staff positions. In addition to these staff members, instructors from VTAE technical colleges and UW campuses would be selected to form action teams. These staff members would serve with a technical person from a Center. They would be assigned to an action project in a specific company. For example, if the XYZ Corporation requests assistance with deploying computer assisted manufacturing technology, an action team would be formed and assigned to this project. The action team would include a technical staff member from a regional center and an instructor from a technical college and another instructor from a UW campus. These instructors would be selected based on the expertise they have related to the problem area. In addition to these staff members, coop or intern students may also be assigned to this action team. (Figure 10)

The action team would go out and work with the company until the technology had been successfully deployed. For the technical staff member from the regional center, this might mean being on-site for one to two years. It is anticipated that the instructors and coop students would spend one school term in the action project. In other words, a given project might include two or three turnovers of instructors and students. The technical staff member from the regional center would provide the continuity and overall direction for the action project.
In some respects this process may appear to be cumbersome. However, it is designed to overcome the constraints that are found in technical colleges and university campuses when this type of action project is proposed. It is often difficult to reassign an instructor for a semester or a year. Campus administrators are reluctant to lose some of their outstanding staff members for a term or two terms. Moreover, instructors are often reluctant to leave their positions.

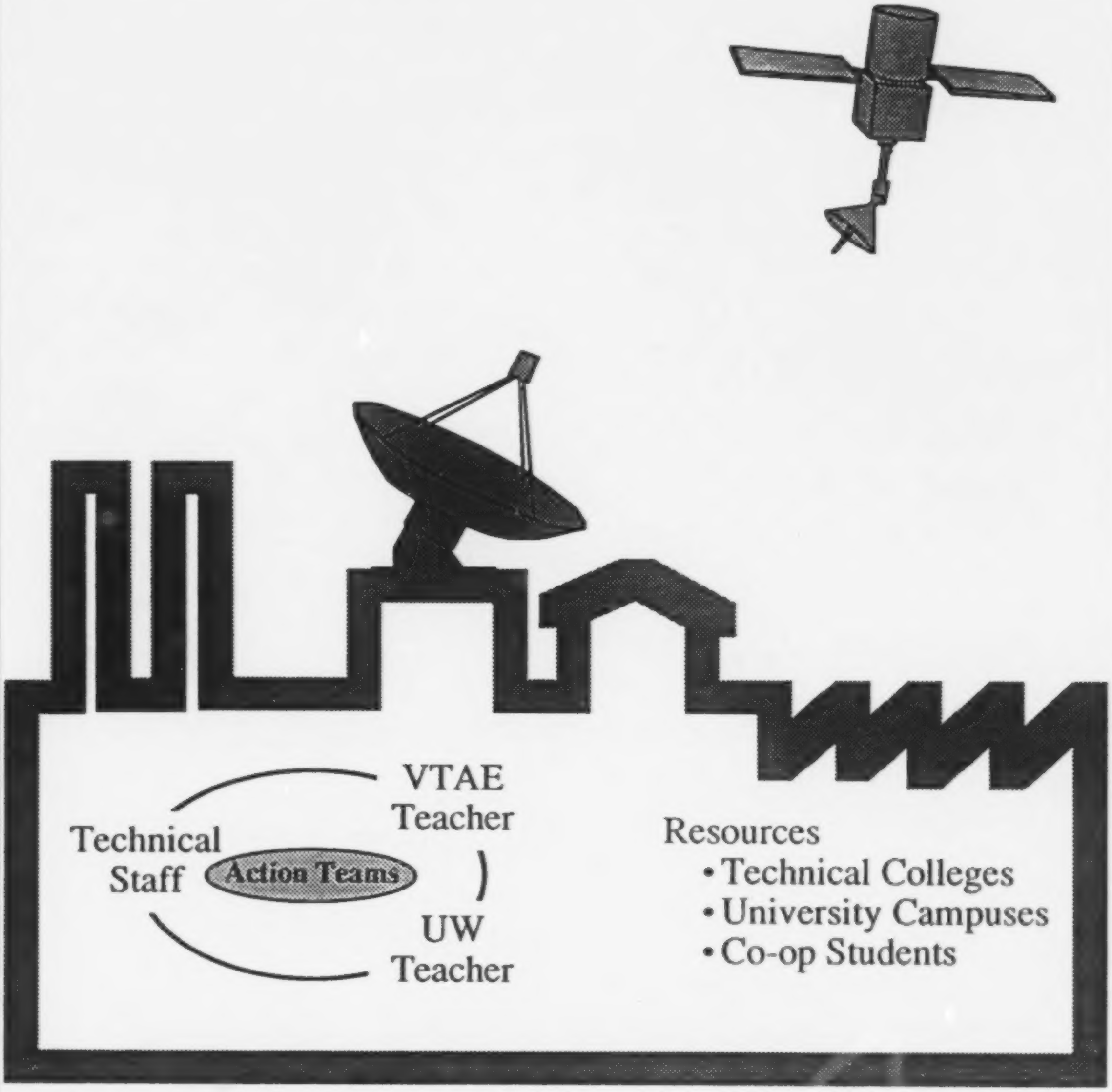

VTAE
Teacher
Technical
Staff
Action Teams
UW
Teacher
Resources
• Technical Colleges
• University Campuses
• Co-op Students

Figure 10: Technology Deployment Teams

Advancement, promotions and other reward systems operating on these campuses often do not fully recognize the contributions made by people who work on action type projects. This design would permit the continuity needed to carry out a long term project and would also allow instructors and students to participate within a timeframe that is feasible for them.

There are several direct benefits from this design. First, the participating company will receive appropriate and effective technical assistance. It will be able to resolve many of its major needs. The instructors involved will benefit through updating their knowledge and receiving an opportunity to work with current technology. They will also have an opportunity to apply the knowledge and competencies they work with in their courses. In addition, they will have an opportunity to identify areas and competencies which need to be infused into their courses, or into other courses on their campuses. The coop and intern students involved will provide needed expertise to the projects, but will also enhance their skills. They will become more adept in applying their knowledge and competencies to practical problems and situations. In addition, they will expand their opportunities for employment after graduation.

The participating technical colleges and university campuses will benefit through the staff development experiences their participating teachers have had. They will also expand and strengthen their contacts with business and industry. Another important impact will be the ideas that come back for improving curriculum and instruction.

In summary, the proposed model was designed with a focus on providing active technology deployment services. A state level office and regional offices were recommended. The regional offices would be staffed to provide in-plant assistance with needs assessment, redesign of production systems, training and trouble shooting. Also, the regional centers will serve as contact points and coordinating agencies. They will bring staff members from technical colleges, university campuses, and other organizations to form technology transfer teams.

9. Determine the resources required to operate the technology transfer system.

The costs for operating the system described in the previous section are based on two separate budgets. The first budget is for the state level technology transfer office. The budget for this center is based on having a full time administrator and secretary. A small amount of consultant money is also provided. It is anticipated that this office will be the interface between state and national level activities in the technology transfer area. Therefore, funds for out-of-state travel have been included. Also, travel funds for an advisory committee were placed in the budget.

Funds for a PC/word processor system are included in the budget. Additional office equipment was not budgeted. It is anticipated that one of the state level agencies would provide office space and equipment for this office. The total cost for the state level technology transfer office is estimated at $117,238. If it is necessary to rent office space and procure office equipment, this amount would be increased by these factors.

The cost to run each regional technology center is described in the second budget provided in this section. The budget for the regional technology center is based on having a full time coordinator and three full time technical staff members. Also, there would be a full time secretary/data acquisition person. The personnel costs are based on providing active services to companies in the region served by the center. In other words, these people would go out on site and work with selected companies until the technology has been transferred and is securely in place. Each center would provide other referral and information assistance as well. The personnel budget also includes $180,000 to cover the cost of six technical college and university staff members who would work with the regional center's technical staff. A center technical staff member and two instructors would form a team to work with a given company. This would bring the resources of the technical colleges and universities into play as the technology is transferred to a company. It would also provide a professional development experience for the college staff members. Funds for coop students are also included in the budget. This would be an educational experience for the student and it would make their expertise available to the companies involved in the technology transfer projects.

No funds are provided for office equipment or rent for the regional center. It is anticipated that one of the educational institutions or possibly a governmental agency in the area would provide these free of charge. A PC for each of the permanent staff members and secretary is included in the budget. This would be a one-time cost that would not need to be repeated in the second and third years of the budget.

Travel funds are included for the permanent staff and the college staff members. This is necessary to provide transportation to and from the companies that are receiving assistance and also for other technology transfer activities that will be initiated by the regional center.

The total estimated budget for each regional center is $615,347. Total cost for the Centers will depend on the number of Centers funded.

State Technology Transfer Office Budget

I. Personnel

A.	Administrator (12 Months)	$ 55,000
B.	Secretary (2,088 Hours x $8.50/Hour)	17,748
C.	Consultants	5,000
	TOTAL PERSONNEL	$ 67,099

II. Fringe Benefits

A.	Staff (29%)	$ 15,950
B.	Clerical (40%)	7,099
	TOTAL FRINGE	$ 23,049

III. Travel

A.	Three National Conferences/Meetings (3 Meetings @ $1,000/Meeting)	$ 3,000
B.	In-State Travel ($600/Month x 12 Months)	7,200
C.	Consultant Travel (5 Trips @ $600/Trip)	3,000
D.	Advisory Committee Travel (9 People x 3 Meetings @ $1,100/Meeting)	3,300
	TOTAL TRAVEL	$ 16,500

IV. Equipment

A.	Office Equipment	$ -0-
B.	PC/Word Processor	6,000
C.	Other	-0-
	TOTAL OTHER	$ 6,000

V. Supplies/Services/Materials

A.	Clerical Supplies ($125/Month x 12 Months)	$ 1,500
B.	Xerox ($175/Month x 12 Months)	2,100
C.	Phone (Monthly Service Plus Long Distance: $120/Month x 12 Months)	1,440
D.	Postage $150/Month x 12 Months)	1,800
E.	Reference Materials	750
F.	Office Rent	-0-
G.	Data Base Services (Assess time, fees, etc.)	3,000
	TOTAL SUPPLIES/SERVICES/MATERIALS	$ 10,590

VI. Total Direct Costs	$117,238

Regional Center Budget (One Center)

I. Personnel

A.	Coordinator	$ 47,500
B.	Technical Staff (3 @ $42,000/Each)	126,000
C.	Secretary/Data Acquisition (2,088 Hours @ $8.50/Hour)	17,748
D.	Consultants	5,000
E.	Substitutes for Technical College and University Staff (6 @ $30,000/Year Academic Staff)	$180,000
F.	Coop Students (6/Year @ $10,000/Year)	60,000
	TOTAL PERSONNEL	$436,248

II. Fringe Benefits

A.	Staff (29%)	$ 52,200
B.	Clerical (40%)	7,099
	TOTAL FRINGE	$ 59,299

III. Travel

A.	Coordinator ($700/Month x 12 Months)	$ 8,400
B.	Technical Staff (3 x $600/Month x 12 Months)	28,800
C.	VTAE/University Staff (6 x $600/Month x 12 Months)	43,200
D.	Consultant (5 Trips @ $400/Trip)	2,000
	TOTAL TRAVEL	$ 82,400

IV. Equipment

A.	Office Equipment	$ -0-
B.	PC and printer for Staff and Secretary (5 @ $5,000/Each	25,000
C.	Other	-0-
	TOTAL OTHER	$ 25,000

V. Supplies/Services/Materials

A.	Clerical Supplies ($250/Month x 12 Months)	$ 3,000
B.	Xerox/Printing ($200/Month x 12 Months)	2,400
C.	Phone (Monthly Service Plus Long Distance: $300/Month x 12 Months)	3,600
D.	Postage $200/Month x 12 Months)	2,400
E.	Reference Materials	1,000
F.	Office Rent	-0-
	TOTAL SUPPLIES/SERVICES/MATERIALS	$ 12,400

VI. Total Direct Costs $615,347

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APPENDIX A

Advisory Committee Members

Advisory Committee Meeting Agendas

Advisory Committee Meeting Minutes

Advisory Committee Members
Technology Transfer Project

Jim Bensen
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Janet Washbon
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AGENDA

VTAE TECHNOLOGY TRANSFER PROJECT

Advisory Committee Conference Call

Monday, March 26, 1990
1:00 - 3:00 p.m.

1:00 **Welcome and Introductions**

1:15 **Review Project Proposal** (Copy distributed in previous letter)

- Purpose
- Objectives
- Project activities and timeline
- Major products to be developed by the project

1:45 **What is Technology Transfer?**

- VTAE paper on technology transfer (Enclosed)
- Your suggestions
- Discussion

2:10 **Technology Transfer Centers to Visit**

- Review site descriptions (Will be mailed to you on March 19)
- Other sites - add any suggestions you have

2:45 **Adjourn**

Minutes of the Meeting

TECHNOLOGY TRANSFER ADVISORY COMMITTEE MEETING

March 26, 1990

This was a teleconference meeting held from 1-3p.m. on March 26, 1990. Persons who participated included: Jim Bensen, Jean Burns, Jim Johnson, Len Keller, Orv Nelson, Larry Schneider, Bruce Siebold, Len Sterry, and Janet Washbun. After a brief round of introductions, the meeting focused on whether Technology Transfer was a process that required a physical facility. Originally it was thought that some considered the concept of Technology Transfer to require a facility to deliver services that were not already being provided. After some discussion, it seems that the focus is now on transfer as a process rather then transfer as a physical facility. Along with this discussion, it was suggested that we use technology to transfer technology.

The discussion focused on a need to carefully assess what is already being delivered in the context of Technology Transfer. It was pointed out that it would not be wise to duplicate efforts that are currently under way. Jim Johnson suggested that transfer must be "hands on" and that it must be more than just words. In other words, it is important to do more than just provide information about transfer of a technology, but in fact, be able to demonstrate and actually do technology.

Jim Bensen commented on technology push, pull, and establishing a potential. In further elaborating, Jim suggested that often times technology is developed and pushed out of our research centers, such as those at a university. He also suggested that industry often works to pull a technology into operation for a specific application. Jim Bensen and others suggested that there should be a close relationship between the push and the pull of technology transfer. However, Jim Bensen went on to discuss the concept of creating a potential. In that discussion, he suggested that it is often beneficial to create the right kind of environment for development and transfer to occur. He suggested that outcomes might be realized from such an environment that go beyond that which was originally planned.

Jim Johnson suggested that we should be clear on what we mean when we use terms like technology and technology transfer. He said that to him technology means making or doing things. Len Keller agreed with Jim Johnson's definition and emphasized that we must be talking about application. Janet Washbun added that technology isn't transferred until people are trained and can actually do something.

Jim Bensen discussed the concept of pure research and pure application. He said that we often conduct research and create new knowledge without having a specific application in mind. He suggested that we might do something similar with pure application. In other words, interpret research, create applications, but not be real specific as to what kind of application we might be considering. From this pool of applications, various industries and businesses could then draw and adopt and adapt possibly to their specific situations and needs.

Then Keller and Jean Burns emphasized that we should survey the VTAE system to see how successful the various districts have been in transferring technology. They suggested that there is technology currently underway and that we need to be sure that we do not overlook existing efforts.

Jim Bensen talked about the business/industry and education "hook-up." He said that business does not know how to work with educators and that educational institutions often times do not know how to work with business and industry. He suggested that a lot of work could be done in finding ways to help make these necessary connections.

Back on the topic of determining what is already being done in technology transfer. Janet suggested we do interviews of district directors to help us determine what is happening at the local level. She said that we really do not know all that is happening outside of state programs.

Larry Schneider suggested that we develop a total package of technology transfer. He said that we need more than just connecting and that we need to bring industry with technical needs together with individuals or organizations who have the expertise. Larry also

emphasized the need to connect technology transfer efforts with course work and instruction that takes place back at the university.
He said there can be an enormous benefit to teachers and students if we make this connection between technology transfer and instruction at the university and technical colleges.

Larry Schneider made a point that we should be very sure to involve University-Wisconsin Extension early in our process of planning for technology transfer.

Len Keller suggested that we involve business and industry in further considering Janet's paper on technology transfer. He suggested that the paper does not address the business and industry involvement to the extent that it addresses educational institutions.

Jim Johnson asked how we plan to consider the needs of small business. He went on to say that often times we pay close attention to large businesses and industries. However, we overlook the "basement operation" and do not provide for the "dreamer."

The discussion focused on additional sites that we should consider for visitations. Jim Johnson suggested that we visit the University of Minnesota at Duluth. He also suggested Michigan Tech. as being a good place to gather additional information. Jim identified a contact person at UMD as Thomas Miller at 313-995-0300.

We already have a site identified in Germany that needs further investigation. Janet suggested that the department of development might have a contact office in Germany. Someone also suggested that Dennis Vanden Bloomen at UW-Stout might know of someone who could gather additional information on the Germany site. While talking about the international contacts a suggestion was made that we talk with Dr. John Stevenson of the UW-Stout International office to see if an arrangement could be made to talk with representatives from Wales. Len Sterry agreed to follow up by contacting Dennis Vanden Bloomen and John Stevenson.

Janet identified two sites that we might want to consider for possible visit. She suggested the technology exchange center in Orange County, California, and the Los Angeles Community College District that has a program specifically designed for retraining displaced workers.

Len Keller talked about a site in Oklahoma. Orv Nelson was familiar with that location and agreed to check out additional details on that site. Jim Johnson suggested that we consider contacting the University of Utah for additional information and following with a visit. Janet Washbun also suggested a site in Blackwood, New Jersey.

Larry Schneider reminded the group that we should be sure to analyze carefully the efforts that are already in place. Jim Johnson added by saying that we need to be flexible because there will be different situations in different parts of the state involving different combinations of business, industry and educational institutions.

Technology Transfer
Advisory Committee Meeting
June 13, 1990
9:00am - 3:00pm
UW - Stout Student Center

I. Welcome

II. Review of staff activities

III. Refreshment Break and discussion

IV. Discuss Technology Transfer Approaches
  A. NIST
  B. Minnesota
  C. New Jersey
  D. Southern Association of States

V. Lunch - Continue Discussion

VI. Present Technology Transfer Framework
  A. Nature of Technology development, application and deployment
  B. Product adoption cycle
  C. Refreshment Break and discussion
  D. Technology Transfer frameworks
  E. Select framework(s) to use in developing the models

VII. Adjourn

Minutes

Technology Transfer Committee
June 13, 1990

The second advisory committee meeting for the technology transfer project was held on Wednesday, June 13, 1990 in the UW-Stout Student Center. All committee members were in attendance. The agenda is included in the attachments to these minutes.

The committee meeting opened with a welcome and introductions. The first meeting of the committee was conducted by a telephone conference call; thus, this was the first face-to-face meeting of the committee.

Len Sterry and Orv Nelson reviewed the project staff members' activities since the last advisory committee meeting. These included reviews of literature, visits to the Greater Minnesota Corporation, discussions with staff members at the National Institute of Standards and Technology in Gaithersburg, Maryland, and a visit to the Camden Community College Campus in Camden, New Jersey. During the next two weeks, Len Sterry will be participating in the Technology Transfer Conference to be held in Boston and visiting Trident Community College in Charleston, South Carolina. Janet Washbon, from the Wisconsin Board of Vocational, Technical and Adult Education staff, will also be visiting Trident.

A brief synopsis of a variety of technology transfer programs was given to the committee. Transparency masters which give the major points related to these programs are included in the attachments. A summary of technology extension services reported in a study conducted by the National Institute of Standards and Technology was reviewed. The 13 programs reviewed in the NIST had budgets totaling 25 million dollars. This was approximately four percent of the total amount reported in the NIST nationwide survey. The budgets ranged from 450,000 to 12.4 million dollars per year. Most of the budgets were in the 500,000 to 1.5 million dollars per year range. The staff size for these projects range from 1 to 122 with an average size of 20. Brief summaries of each of the programs reviewed are contained in the attachments.

During the discussion of these programs, it was noted that some emphasize in-depth and active transfer technology. These programs serve fewer people at a higher cost per firm. The programs that serve as brokers and refer companies to other resources, can assist a larger number of clients at a lower cost per client. Although there is not a lot of research available, the one study that was reviewed by the project staff indicated that projects which take an active approach are much more successful than those that take a passive approach. An active approach would be one in which technology transfer staff go out and work in the business or industry until the appropriate technology has been transferred and is securely in place. A passive approach is one which information is shared with the client and the client may be referred to other resources. It was also noted in the summaries that a majority of the technology transfer activities involved transferring off the shelf technology.

The various units and people contacted during the NIST visit were discussed. The NIST program managers consistently emphasized the importance of a state presenting a unified approach when it applied for funds managed by NIST. Project staff members also visited the Machine shop of the 90's and Energy Related Inventions unit while at NIST. The Machine shop of the 90's was developed in response to needs. First, a number of operators of small machine shops indicated that the work being done on the Advanced Manufacturing Plant was not useful to them. They needed more appropriate and affordable technology. Second, the machine shop operated at NIST had to be competitive with other vendors. In order to do so, they found it necessary to automate many of their processes.

During the NIST visit the project staff members also had an opportunity to talk with the director of the Malcolm Baldridge Quality Award Program. Advisory committee members noted that this is an important component of a technology transfer program. Many smaller companies are now being asked to, at least, apply for the Baldridge Award in order to be eligible to be a vendor for a larger company.

After visiting NIST, project staff members visited Camden Community College in New Jersey. Camden Community College has recently completed a manufacturing center and laser/optics center. The manufacturing lab had a large open area in the center where automated systems could be assembled and operated. This area was surrounded by a series of smaller laboratories in which students could work with tabletop systems.

The goals of the Southern Technology Council were reviewed. This council is comprised of a consortium of southern states. An advanced manufacturing center funded by NIST is included in the consortium. A network of two year technical colleges participate in the technology transfer process. Trident Community College is a part of this consortium.

Len Sterry reported on his conversation with Glyn Phillips from NEWI, Northeast Wales Institute in Wales. Dr. Phillips has done an extensive study of the technology transfer process and has incorporated his findings in programs at NEWI. He has authored a book and the project is in the process of trying to acquire it.

The relationship between science and technology was discussed. Committee members noted that technology was doing problem solving, and creating a product.

The project staff discussed a variety of possible technology transfer program components. These are summarized in the overhead transparency masters which start with the master for "Technology Deployment and Training." A variety of components were presented. The consensus was that the technology transfer model should focus on technology deployment and training. The other components should be ancillary to this emphasis. Figure 1 shows a graphic sketch developed during the discussion.

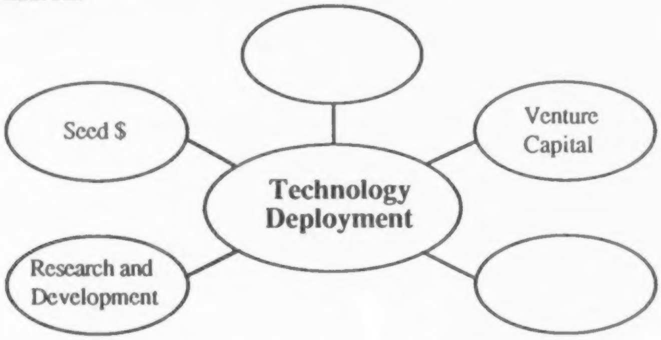

Figure 1: Technology Transfer Model

Many ideas were presented during the meeting. Most of the suggestions were such that they could be written as criteria to provide direction to the development of a technology transfer model for Wisconsin. Below is a list of these criteria:

1. The technology transfer mission should be broadly defined; however, it must fit within the definition of technology.
2. Science and technology are related but different. This project will focus on technology transfer.
3. For purposes of this project, technology will be defined as a process of making or doing something.
4. There will be a clear statement of how organizations and agencies relate to one another. VTAE will want to be able to stage or position itself within the big picture.
5. The major focus will be on technology deployment and personnel training.
6. At the outset there will be three pilot centers, each with three major activities.
7. Pilot sites will be selected on the basis of interest shown in response to a "Recruitment For Proposal," (RFP). Criteria will be developed, e.g., geography may be a factor in site selection along with interest and cooperation between players. Additional sites will be added in subsequent years.
8. Staff will be upgraded through involvement.
9. Students will benefit through direct involvement and as a result of staff involvement.
10. Activities will be proactive as well as reactive. Ask prospective clients what they need, but also make proposals that could be in their best interest. Technology "push and pull."
11. Serve a manageable number of clients and serve them well. Don't evaluate only on the basis of "nose count." Measure quality of service.
12. Serve small entrepreneurs and innovators as well as large organizations.
13. Provide easy access to technology and services.
14. Technology transfer is a dynamic process; it will keep changing.
15. Provide something physical. It will probably be a building.
16. Devise a means of motivating and rewarding staff.

At the end of the session it was decided to have the third meeting of the committee on Monday, July 16. The meeting will be at the Holiday Inn in Tomah. This will split up the driving for the members involved in the committee. The July sessions will focus on reviewing the technology transfer program models developed by the staff.

The meeting adjourned at 3 p.m.

jb

Agenda

Technology Transfer Advisory Committee - Meeting 3

July 16, 1990

Holiday Inn, Tomah

Agenda

9:45 - 10:00	Welcome and Informal Conversations Complete travel forms
10:00 - 10:10	Overview the Meeting Goals
10:10 - 11:00	Discuss Technology Transfer Models • Review Decisions at June Meeting • Review Process Model • Review Structural Model
11:00 - 11:10	Coffee Break
11:10 - Noon	Continue Discussion of Models
Noon - 1:00	Lunch and Continued Discussion
1:00 - 1:45	Cost to Implement Models
1:45 - 2:30	Discuss Changes in the Models
2:30 - 2:45	Coffee Break
2:45 - 3:15	Discuss Next Actions
3:15 - 3:30	Wrap up and Adjourn

Minutes Technology Transfer Advisory Committee Meeting
July 16, 1990

The third meeting of the technology transfer advisory committee was held at the Holiday Inn in Tomah, Wisconsin on July 16, 1990. The meeting convened at 10:00 a.m. with a review of the objectives for the session. After that the technology transfer model outlined during the June meeting was projected and discussed. New visuals and information on the technology deployment emphasis in the model were presented. Some suggestions were made to refine the deployment function and refine the definition of terms that went along with it. Relationships between the regional centers and state-level office were discussed. The discussion indicated that it would be desirable to be able to implement at least two regional centers, however, funding problems may make it impossible to do this. The recommendation of the committee was to establish at least one center and try the model.

A draft budget for the operation of the state-level office and an individual center was reviewed. Overall, the cost estimates were accepted by the committee. It was the committee's judgement that it should be possible to obtain office space and some office equipment from the host agency. Therefore, it was not placed in the budget.

The researchers were asked to prepare a narrative for the technology deployment model and check the budget figures. The researchers were also asked to prepare a description and rationale for the technology transfer teams and the partnerships that would be formed by having a technical college teacher, university teacher and a technology transfer center staff member work together in business and industry. The impacts of these experiences would also need to be detailed. The researchers were asked to forward this information to Janet Washbon by the end of July. The meeting was adjourned at 3:00 p.m.

APPENDIX B

Revised Activity and Time Schedule

Revised Activity Time Schedule for the Technology Transfer Project

(Revised 3/20/90)

Research Activities	Schedule
1. Identify advisory committee members (Dwight York, WBVTAE and Charles Sorensen UW-Stout are responsible) • Six to eight members • Represent VTAE, Stout and B/I	February 20-March 2, 1990
2. Identify technology transfer centers that are active in the U.S.	February 20-April 16, 1990
3. Contact technology transfer centers by phone to obtain current information on their status.	March 7-April 16, 1990
4. Review documents, data bases and literature on technology transfer and technology transfer centers to identify approaches to technology transfer, organizational structures, partnerships critical variables, programs of work and evaluation results.	March 7-May 24, 1990
5. Meet with project advisory committee. (One day meeting) (If appropriate, a consultant will be invited to this meeting.) • Review technology transfer systems • Discuss technology transfer centers • Select centers to visit • Identify questions for site interviews	March 26, 1990
6. Contact selected centers and schedule site visits.	March 27-April 13, 1990
7. Continue review of technology transfer documents.	April 2-July 15, 1990
8. Conduct telephone survey of State Technology Transfer Centers.	April 2-May 1, 1990
9. Conduct site visits at selected technology transfer centers. • Two to three days/center • Meet with staff, partners and clients • Review program of work and activities • Discuss factors and conditions that facilitate and inhibit technology transfer	April 9-May 23, 1990

10. Project, WBVTAE and Stout staff who conduct on-site visits summarize data, experiences and impressions.	
• Individuals review their notes and write summary comments.	After each visit
• One day review meeting to discuss results and perceptions. Group will develop a consensus on the conditions, factors and resources required for technology transfer before the close of the meeting.	May 24, 1990
11. Project staff develop the framework for technology transfer centers. This may include: • Major functions • Partners and relationships • Concepts and strategies • Processes and activities • Support services	May 25-31, 1990
12. Discuss framework with project advisory committee (One day meeting) • Discuss and evaluate framework • Identify changes in the framework • Discuss use of the framework in creating the technology transfer model for Wisconsin	June 1 or June 4, 1990
13. Refine the framework	June 5-8, 1990
14. Develop the technology transfer model for Wisconsin	June 11-20, 1990
15. Design a draft implementation plan for the model	June 21-26, 1990
16. Review the model and implementation plan with the project advisory committee and consultants. (One to one and one-half day meeting) • Review the model • Discuss changes needed in the model • Review the implementation plan • Discuss changes needed in the implementation plan • Discuss a budget for the implementation plan	During period of June 27-29, 1990

17.	Revise the model and implementation plan and refine implementation budget. Send to advisory committee for reactions and suggestions.	June 25-July 19, 1990
18.	Make final revisions in the model and implementation plan	July 20-August 2, 1990
19.	Submit final model and budget to WBVTAE	August 3, 1990
20.	Assist WBVTAE staff develop funding proposal	August 1-Sept. 30, 1990

APPENDIX C

Site Visit Reports

Unified Technologies Center
Cuyahoga Community College-Cleveland Ohio
Meeting with Michael Taggart

The mission of technology transfer at Unified Technologies is to provide service and training for a competitive climate for the area. That includes: development of a skilled work force in both technology and management. They admitted that technology transfer was a difficult concept to define and that each state probably defines it differently.

Many different services were available from the Center. Some of these include: technology demonstrations, seminars, forums, technology assessment, referral services, educational programs, and training. In addition, they provide skilled testing and assessment of employees, determining training needs after the assessment and providing education and training programs. Teleconference and media services are also provided. These included: multimedia presentations, satellite uplink capability, and conferencing.

Unified Technologies also provides educational support for the faculty at Cuyahoga County. These programs include: faculty development, instructional design, and resource sharing.

The majority of the start-up money for the Center came from the Higher Education Board of Regents. This included 1.8 million dollars for the building, 1.1 million dollars for furnishings, 1 million dollars for communication technology and, 2.5 million dollars for the manufacturing equipment and start-up. An additional 2.8 million dollars for capital equipment came from the Department of Development.

During the first year the Center was staffed with 56 persons. That was scaled back to only 19 individuals for the second year, and back up to 29 at its current status.

The long range design for the Center is to make it self-sufficient. Each year less money is requested from state operations and more of the expenditures are paid by clients as they purchase services. They emphasize that they want to operate the Center as a business. They emphasize that they do not attempt to compete with private industry. As a result, they price their services in a way that is comparable to the open market. They compete by providing high quality service, rather than reduce costs. Some operational funding will come from local taxes.

Summary of Visit to the Greater Minnesota Corporation

Greater Minnesota Corporation
April 12, 1990

Project staff members visited with Bruce Merrifield, Interim President of the Greater Minnesota Corporation and two of his staff members, Thomas K. Rice and Emily Galusha, on April 12. The Greater Minnesota Corporation is developing a comprehensive technology transfer program. The technology transfer activities covered span the spectrum from encouraging the development of basic knowledge through the deployment of proven technology.

There are five major components in the Greater Minnesota Corporation program. These include the following:

- Business Innovation Centers/Technology Field Offices
- Applied Research Institutes
- Technology Research Grants
- Minnesota Advanced Manufacturing Technology Centers (MAMTC)
- Seed Capital Programs

The services of the Business Innovation Centers/Technology Field Offices include assistance with product design, market analysis, production improvement, and information on technology innovations.

The Applied Research Institutes include agriculture utilization, Minnesota International Technology Center, and Natural Resources. Institutes for biotechnology, supercomputers and composite materials are being developed.

The Greater Minnesota Corporation is attempting to encourage business innovation and technology applications throughout Minnesota. It is trying to avoid competing with other organizations working in the same areas. It is attempting to establish networks throughout the state. A set of out-of-state centers is being developed.

The Greater Minnesota Corporation is funded through appropriations from the Minnesota legislature, a part of the profits from the Minnesota Lottery, and grants from foundations and governmental programs.

Staff members are studying technology transfer activities and projects in other states. In addition, they are also exploring the networking systems used in many European countries.

Summary of Meeting with Minnesota Advanced Manufacturing Technology Center
May 23, 1990

W. Bruce Hardman
Executive Director

The Minnesota Advanced Manufacturing Technology Center is a public/private partnership commited to enhancing the competitiveness of Minnesota and U.S. manufacturers in the global economy by:

1. Integrating business, labor, education and government.
2. Excelerating the utilization of advanced manufacturing technologies, systems, managment practices and cooperative relationships.
3. Empowering people and manufacturing to adapt to rapidly changing environment.
4. Insuring growth and worldwide leadership.

MAMTC has three emphases that include the Minnesota Manufacturing Institute, Regional Centers and the Minnesota Manufacturing Assistance Program.

The Minnesota Manufacturing Institute is the core center of MAMTC and will be located in the Minnesota technology cooridor close to the University of Minnesota Institute of Technology's Productivity Center, the SuperComputer Center and a large base of expertise in the Twin Cities. MMI will focus on applied research and development, technology demonstration, advanced training and information services.

The regional centers throughout Minnesota will serve the industrial needs of their communities. MAMTC will solicit proposals from regional coalitions of private/public groups and companies for forming regional centers, and provide start-up funding as well as assistance in identified funding sources. Regional centers offer potential services in strengthening manufacturing, collecting data on manufacturers by regions, and coordinating services with the Minnesota Manufacturing Institute.

The Minnesota Manufacturing Assistance Program will provide expertise and counsel to individual manufacturers statewide by assessing their operations and making specific recommendations for training, implementing technology or changing management practices. Professionals in training and technology will offer expert, unbiased counsel tailored to the small and mid-size manufacturer at a modest price or no cost to the client.

In addition to the overview of the function of MAMTC, Bruce Hardman made a number of comments that should be helpful as we develop a comprehensive technology transfer plan for the state of Wisconsin. Bruce commented that most of the training that takes place is hands on and uses industry facilities to the extent that is possible. MAMTC cannot afford to equip laboratories in a rapidly changing environment. As a result, they work closely with industry and technical schools. He pointed out however, that classroom training is offered, but only in areas where it does not conflict with services already being provided by technical schools. He emphasized that they coordinate training between MAMTC and other institutions that offer training programs.

Bruce pointed out that there is a need for management courses as a part of the total technology transfer process. He indicated that across the country there exists a great deal of very good technical training, but that there is also a need for management training. Industry is apparently saying that technical innovation cannot take place without an understanding and commitment on the part of management. As a result, there is a need to train management to make them aware of ongoing and emerging technology that might be useful in their respective organizations.

Bruce Hardman said that MAMTC is in the process of developing a proposal for NIST. The thrust of the proposal will be on multi-state distance training. In other words, it will be a consortium proposal that will provide for an assessment of individual state needs and then a multi-state distance delivery that, in some cases, will be available for university credit.

When asked the question about funding, Bruce indicated that MAMTC is funded through The Greater Minnesota Corporation, by private grants from business and industry, usually in the form of hardware and software, and by appealing independently to the legislature for funding. He did indicate that there was some overlap. However, to this point they have been able to make a case for separate funding from the legislature as well as funding from the legislature through The Greater Minnesota Corporation. Bruce went on to say that they will be receiving five million dollars this year from GMC, whereas they only received two million dollars for the past year. He went on to say that the operation will never be self-supporting because they must provide free and inexpensive services to the clients they are serving.

MAMTC is also working on a project called Project Outreach. This is an attempt to develop a pool of expertise that can be put on a data base and networked in such a way that services needed can be matched up with services available. Bruce indicated that they are asking each governors office from the great lakes state to contribute $50,000 toward the development of this data base.

We asked Bruce Hardman about what is happening in technology transfer on the international level. He indicated that many countries were well ahead of the United States in working with technology transfer. He cited Denmark, Germany, Norway and Italy as good examples of transfer activity. We also asked Bruce about strategies for designing and implementing a technology transfer program. We asked about legislative involvement specifically. Bruce suggested that we involve legislatures early in the planning process. He also suggested that we involve both those who support the idea and those who might oppose it. Bruce suggested that we have industry talk directly with legislators at some appropriate time in the planning process.

When asked about an evaluation process, Bruce suggested that we will need more than just raw number to substantiate success. He said that although numbers help and lead to generalizations, we need to be able to talk in terms of, for example, jobs developed or jobs saved, or industries that have received specific assistance from the effort.

National Institute of Standards and Technology
Gaithersburg, Maryland 20899

May 16, 1990

Meeting with Joseph Berke

Joe Berke was our host for the day. He made arrangements for a visit and organized all the persons with whom we met during the course of the day. As a result, we had various opportunities to talk with Joe. We discussed a variety of topics as we moved from meeting to meeting and also had a summary session near the end of the day. As a result, many of the ideas summarized in this report are more a consensus than any specific points. It seems that as we develop the technology transfer concept for Wisconsin, we need to pay attention to at least several important functions. These are:

1. Make potential clients aware of the services that can be provided.
2. Help clients to define their problem carefully.
3. Find information for the client based specifically on the problem that has been identified.
4. Make the information readable and understandable to the client. Be sure that there is a direct connection between the information provided and the problem that was originally identified.

In addition to helping clients define their perceived needs it may be appropriate to gather information and make proposals to various organizations for their consideration. It seems that many organizations have difficulty defining their problem or realizing that, in fact, they have a problem.

An example of this could be in the area of manufacturing. While some firms are operating with state of the art equipment, the majority are functioning with technology that is as much as twenty years behind the state of the art. Often times these organizations are not aware of how they can improve in. In some cases, they could improve quality and productivity by making relatively minor adjustments in their technology and production techniques. In this example, it might be appropriate to propose suggestions and to offer them to industries in such as way as to not be threatening to their current organization, but in fact, provide information for their consideration.

As we look at an overall concept of technology transfer, the following diagram might help to clarify some possible relationships between clients and various and help agencies. For example, the focus of many of our efforts would be on the business, industry, government or educational client. In Wisconsin we have numerous organizations that are in a position to be of assistance. Our technology transfer effort might serve to coordinate the services that are available and offer a smorgasbord of possible assistance to our clients. Some of the organizations that are already in a position to be of help include: universities, technical colleges, private consultants, small business organizations, state agencies, and economic development organizations. It would be important for us to try to solve problems of Wisconsin clients with Wisconsin resources and agencies. It seems that the more local we can keep the service the more effective it is likely to be.

Awareness	Define the Problem	Locate Resources	Communicate Findings
• That help is available. • That they might be able to improve quality & production. • That new potentials exist.	• Help them identify the "real" problem. • Help them define the problem, specifically.	• Technology. • Training. • Money.	• Concise. • Specific. • Understanding.

If when state resources and organizations are not readily available or in the position to solve a problem, it might be necessary to move out into the nation or possible internationally to locate the solution. It seems that in most cases, about 90 percent of all problems can be solved at the state level. For the difficult, specific problems that might become apparent, it may be necessary to reach beyond the state for solutions. In this case our technology transfer unit could work with the Federal Laboratory Consortium through NIST and their network of experts in some 500 affiliated federal laboratories throughout the United States. NIST is in a position to assist with technology transfer in this way. They seem very willing to provide a linkage between state efforts and the national laboratories.

As we work with organizations and problems that they perceive to have, we need to focus on specifically where they are at this point and where they would like to be at some point in the future. Our assistance would be to coordinate resources to move them from where they are today to where they would like to be in the future. Areas of assistance might fall into technology, training and financing. In other words, our task might be to find an appropriate technology that will be of assistance to the organization and to assist with the transfer of that technology, and also to be of assistance in providing training that would be necessary to enable people to interface and use the technology to its best advantage. Finally, we might be able to find financial resources that could be available to the various organizations as they work to address their problem.

Shop of the 90's

NIST Visit
May 16, 1990

During the NIST visit, the researchers had an opportunity to visit Adrian Moll and see the Shop of the 90's which has been constructed at the National Institute. Adrian Moll is Chief of the Fabrication Technology division of the National Institute of Standards and Technology. Adrian's shop has two purposes. First, it develops scientific apparatus for the various laboratories that are a part of the National Institute. Second, it is a demonstration laboratory for the application of new and advanced technology in the machine tool industry.

Originally, Moll started out to develop an advanced state-of-the-art machining center. However, when he invited in a group of machine shop operators from the region to view his plans, their feedback was not encouraging. They commented that the technology he was developing was interesting, but of little value to them. They indicated a need to be able to apply new technology to their current equipment. In addition, the changes had to be financially feasible for them.

As a result of this feedback, Moll and his staff started to develop software and hardware applications that would be feasible for small to medium size machine shop operators. They developed software to aid cost estimation, process planning, tool room management, and job cost tracking. They also included CAD and CAM systems that were operated by personal computers. As a result of their work, they have been able to automate a number of routine machine shop tasks.

Adrian Moll and his staff are now offering workshops for machine shop operators and educators who are interested in these applications. Information on these workshops can be obtained by contacting Adrian Moll at the National Institute of Standards and Technology in Gaithersburg, Maryland 20899. His telephone number is (301) 975-6504.

National Institute of Standards and Technology
Gaithersburg, Maryland 20899

May, 16, 1990

Meeting with Kathy Leehy

Kathy Leehy is Director of the Quality Awards Program sponsored by NIST. The objective of the program is to recognize up to six quality organizations each year as recipients of the Quality Award. Although six awards can be granted, it is not, however, necessary that six will actually be awarded in any given year. Several different categories of awards exist, such as large and small organizations, as well as, service and manufacturing organizations.

The Quality Awards program exists for the purpose of recognizing excellence. Several other benefits are of equal and possibly greater importance. For example, to meet the high standard of quality, organizations must attain given criteria identified by the program. As a result, businesses and industries can use these criteria as a measure of improving their own standard of quality within their restrictive organizations. In addition, organizations such as Motorola require that all of their suppliers must apply for the Quality Awards program. This ensures Motorola that their suppliers are at least aware of the program and are striving to meet the level of excellence spelled out by the criteria.

Kathy pointed out that some organizations, such as, AT&T, IBM and Westinghouse use the criteria for in-house awards programs. That is, various units within these industries strive to meet high levels of quality by attempting to attain the standards spelled out in the awards program. She also indicated that some states have established statewide awards programs for various businesses and industries based on the criteria of the program.

As we discussed our possible role as a technology transfer concept, it was suggested that a university such as Stout might wish to offer a course for business, industry, government and educational organizations about how they might strive to meet the level of excellence identified by the program and, to in fact, apply for a National Quality Award. It was further suggested that we might want to include international trade standards in such a course, should we decide to make an offering. If we do include international trade, then we should consider both the technological standards of acceptance, as well as, the political and trade agreement requirements.

Joe Berke suggested that small universities could play a major role in working with business and industry because they are small, close to the people and are interested in providing services. This might also be an argument for why technical colleges could play a similar role. He pointed out that large universities are often more interested in working in sure research and that they are sometimes not interested in implementation.

During our discussion, Kathy mentioned that there is a person in the Madison area, by the name of Barbara Hummel, who is affiliated with the Area Quality Improvement Network. She said that we might wish to contact this organization to gather additional information about what they are doing with quality improvement.

When asked a question about how good companies attain high levels of quality, Kathy said that they, in fact, have standards to strive for, are close to the people and companies they serve, have good quality tracking (know how to measure quality), have good benchmarks, gather information, know where help is available, involve employees, empower employees (flatten the organization), have self-managed work cells and engage extensively in employee training. She pointed out that training is often overlooked and under funded; however, it is probably the most important ingredient in a quality program.

We asked a question about the extent to which service companies might apply to quality standards. Kathy responded by saying the standards are generic and applied to both manufacturing and service organizations. She said an additional role that we might play as a technology transfer concept, or, a university or technical college is that we might want to help service organizations measure quality. She indicated that often times we can measure quality more easily in a manufacturing environment than we can in a service oriented organization.

Camden Community College
May 17, 1990
Meeting with John TenBrook

The work in technology transfer at Camdon Community College involves computer integrated manufacturing and laser/fiber optic technology. They have a new facility of about 40,000 square feet designated primarily for C.I.M.. They have just completed another building of about 10,000 square feet which they will occupy during the fall of 1990.

The work in technology transfer includes industrial training, applied research, demonstration activities for firms such as IBM, small production runs for companies, serving as a broker of services and incubation. Industrial training is a continuing function and takes place both on and off site. The applied research activity is limited to small projects. Demonstration site functions are, at this time, limited to the connection with IBM and computer integrated manufacturing. The Center serves as a regional training facility for IBM equipment. Small production is an ongoing activity that involves both faculty and students. Working as a broker of services and providing incubation for small companies are two activities that are in the long range plan but are not yet operational.

Dr. TenBrook suggested that we often use advisory committees to help us determine the kind of instruction or services that should be provided for business and industry. He added that , although that is an appropriate use of advisory committees, we as educational institutions, particularly if we are involved with technology transfer, should be in a position to develop improvement plans that can be taken to industry as suggestions for improving both quality and productivity. He made a point that many industries are operating well below the state of the art capability of technology that exists today. Often times they do not realize that they are functioning as inefficiently as they are. As a result, taking ideas to them provides a valuable service, that without help, they would not recognize what they actually need.

As we visited the national institute of standards and technology, we heard a presentation about the work that is being done to help small shops automate. This concept was again addressed by Dr. TenBrook as he pointed out that small shops can automate particularly as personal computers become capable of using software at a relatively low price

As we discussed equipment, Dr. John TenBrook indicated that they recently had to rethink their notion of full scale equipment that is similar to that in industrial production facilities. He indicated that Dr. Del Ellis at Bringham Young University, was doing considerable research on the effects of using tabletop technology to simulate actual production processes. John indicated that after he visited Brigham Young he realized that it was appropriate for Camdon Community College to move from their original thought of "Big Gun" technology to a scaled down version of mini units. He indicated that in his judgement, the real answer is in some blend of full scale equipment and tabletop units.

Summary of Visit to Trident College, Charleston, South Carolina

Trident is a part of the Southeast Manufacturing Technology Center. It is funded by the National Institute of Standards and Technology. The project is designed to enable business and industry to interact with South Carolina universities and State Board of Technical and Comprehensive Education. This technology transfer process focuses on manufacturing technology transfer. However, the long-term hope of the project is that the scope will be broadened to include other industries as well. The effort is currently organized such that overall coordination takes place at the university level and four regional centers are housed at technical colleges. This organization provides for central coordination; however, services are delivered at the local level. Such an organization also eliminates the duplication of facilities, equipment and staffing. It further provides an easy means for faculty and students to become involved with industry projects.

In addition to the organization, another interesting factor at Trident includes the way in which they have equipped their laboratories and provided instruction for students. Automated manufacturing systems are constructed by faculty, rather than purchased as commercial packages. The design and construction of the learning stations by faculty provides an opportunity for staff to become involved and trained in automated systems. They do this by designing and constructing the modules themselves. As a result, the modules become true learning stations for students; this is different from what we saw in other locations. In some other cases, automated manufacturing systems were purchased and as a result provided fewer learning experiences for students and less flexibility. In the case of the Trident example, students could study specific technologies and then integrate those into systems of automated manufacturing.

Northeast Wales Institute of Higher Education (NEWTECH)

Discussion with Glyn Phillips

NEWTECH Innovation Center is run by Clwyd County Council and the Northeast Wales Institute. It is a regional focus for technology-based business development. NEWTECH provides a subsidized advice service for new and growing businesses.

As a part of the network of science parks and innovation centers throughout Europe, NEWTECH offers direct access to international markets and technology opportunities. Assistance is provided in business development services, technology support and business consultancy and training.

Business Development Services

NEWTECH deals with about 200 business proposals each year. Their objective is to select the best projects and to remove all obstacles, including finance. In brief, they state that if you have what it takes, you will get what you need.

Services provided for business development include: initial assessments, business counseling, technology assessment, advice on grants and loans, assessment and improvement of managerial skills, advice on business microcomputer systems, communication-conference and meeting facilities, business planning, market assessment, access to finance, and patent protection.

Technology Support

Expertise in the technologies is available at NEWTECH for: product development and analysis, technical evaluation and prototype design and construction. Their facilities include: biotechnology, chemistry, computer applications, computer aided engineering, work and design facilities, microbiology, food analysis, material science, control engineering, and technical information.

Business Consultancy and Training

NEWTECH's consultancy services include: business planning, quality assurance, effective management, financial and information systems, a language and export center, open learning programs, marketing design, technical assessment, technology transfer, and business information.

During the discussion with Glyn Phillips, he talked about another Center that is currently under development. Apparently NEWTECH is located in the northern portion of the county. The new development will be in the southern portion of the county, and will emphasize medical services. In fact, the new Center will be titled MEDTECH.

As we talked with Glyn, he made several points and suggested that we look at his recently published book titled, Technology Transfer and Innovation In Europe and Japan. Apparently, he has done considerable research and has decided to summarize his work in this publication. We have ordered the book, however, it has not yet arrived.

Glyn also suggested that we provide services with a focus or a one-stop shopping center. He said that based on their experience, there are many people and organizations that are trying to help, but they do not have a central focus and potential clients do not know who to contact. He pointed out that this is apparently a problem here at Stout under our current organization.

It seems like we should take a careful look at what NEWI and NEWTECH are currently doing. They have had considerable experience, found success and are expanding their venture. In addition, however, this connection could open the entire European market to our technology transfer efforts. We already have a relationship with NEWI and we have a presence, at this time, in Scotland. NEWI could provide us with visibility to European community, and other connections that they have, while we could provide NEWI with contacts here in the United States and more specifically, Wisconsin.

APPENDIX D

Technology Transfer: A Literature Review

TECHNOLOGY TRANSFER

A Literature Review

by Ann McNattin

submitted to Dr. Orville Nelson
Center for Vocational, Technical and Adult Education
University of Wisconsin-Stout

August, 1990

Facility

Purpose: Develop a facility to provide a focus or presence. It should have unique services, but not duplicate facilities already in place.

Potential Activities:

- Provide a site for manufacturers and vendors of industrial equipment to use as a demonstration and training center.
- Serve as a clearing house for services.
- Provide communication and networking.
- Become an authorized training site for vendors.
- Provide visibility for potential support.
- Provide office space for staff.
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•
•

FACILITY

Many authors writing on technology transfer describe the facilities developed for or adapted to the technology transfer goals of their particular institutions. These facilities appear as varied as the institutions utilizing them, and as diverse as the faces of the technology transfer itself.

Sollie and Howell (1981), of the Southern Rural Development Center, describe the facilities they have developed to accomodate the technology transfer needs of Mississippi and other states in the South. The Southern Regional Development Center is one of four regional rural development centers in the country, and focuses specifically on rural problems and technology transfer needs of the South. Funding is received through the USDA, and the Center is jointly sponsored by Mississippi State and Alcorn State Universities, providing support staff for capacity building and innovative programming for the experiment stations and extension services of 28 land-grant universities in 13 southern states and Puerto Rico.

Specific to technology transfer requirements, Sollie and Howell describe MSU's Center for Government Technology. This is operated as an arm of the Cooperative Extension Service, and serves as a training site for city clerks, assessors, and tax collectors, as well as a seminar and training site for such diverse needs as road maintenance, personnel administration, computer procurement, jail operations, and inmate management. The Center also exists to respond to local requests for assistance, having on staff specialists and generalists trained to provide technical assistance in cooperation with the Center's many programs.

On the basis of the model presented by MSU's Center for Government Technology, Sollie and Howell propose a Community Services Office which might serve as a knowledge transfer and service delivery coordinating point. They describe one basic function as that of a clearinghouse servicing the information exchange needs within the University. The second function of such an office would be one of linkage, not so much to inject itself into established university-user relationships, but to assess on a continuing basis the number and variety of client systems and the changing needs and problems of the public sector, and coordinating and facilitating linkage between them.

These authors also propose, as a unit of such a community services office or as an independent entity, a University Faculty Resource Data Bank, which would use a telephone hotline to make available the expertise of various faculty and staff when particular needs arise within the community served by such a phone service. They propose that such data on faculty expertise be stored using the Social Mapping Matrix Assessment (SMMA), which can provide the potential user with "next-best" referrals when no direct match is located between user need and faculty offering.

Among the models for Sollie and Howell's work in Mississippi is the Title V program at Pennsylvania State University (Sollie & Howell, p. 25), which program emphasizes capacity building in local communities working in rural development. Interaction between local community people and Penn State researchers is reported to frequently result in applications of a problem solving process designed by the local users themselves. A Community Development Specialist acts as a consultant with access to technical information, also serving as meeting organizer, researcher, and general liaison as the needs arise. This role of Community Development Specialist was likened to the role of of the circuit rider, maintaining university-user relationships and servicing client systems.

Parsons (1983) looked at technology transfer from the vantage point of the opportunities and demands placed on the community college system by the continuing advances in American technology. He stated, "Few community colleges have the resources to be technological innovators. All, however, have the capability of identifying appropriate technological innovations emanating from research and development agencies." He looked to the National Center for Research in Vocational Education at Ohio State University for the data from their 1982 technology-adaptation project, which study concluded, as does Parsons, that the community college is the ideal broker for the nation's technology transfer efforts, since these institutions are already providing programs and services tailored to the unique needs of local business and industry.

One of the clearest examples in the literature regarding this notion of community college brokerage of technology came from Illinois (1989), where the community college system is federally, state, and locally funded, and where community colleges are increasingly equipped with state-of-the-art equipment, dictated by and serving the needs of the industry in a particular college's region of the state. Local businesses have been invited to petition the Illinois Community College Board with their employment and training needs, and insofar as possible these needs have been met through adaptations in community college curricula and physical improvements to the community college site in order to implement this need and offer students training specific to the local job market which awaits them. Industry professionals have been instrumental in designing such changes and programs/coursework, and have even served as instructors in some of the community college coursework specific to their industry. Therefore, while some more generally applicable community college offerings can be found at many of the Illinois community college sites, others are not consistent across the state but rather serve the regions of the state offering highest employment potential. The students and industry are thus both well served, since community college training spares the employer the onus and expense of on-the-job training, and students find ready employment upon completion of the curriculum without needing to specify their skills through internships.

Ohio is another state which has discrete locations for implementation of technology transfer (Ohio Board of Regents, 1982). The Ohio Technology Transfer Organization (OTTO) was created to provide "coordinated access to the technical information, services, and counsel available through Ohio educational institutions, state, and federal agencies." A full-time OTTO agent is located at each of fifteen technical and community college campuses to help small business enterprises learn and use current technical knowledge. The Ohio Coal Research Laboratories Association, Inc. (OCRLA) serves the needs of the coal industry specifically, through offices in colleges and universities across the state and at such other research organizations as Batelle's Columbus Laboratories, the Air Force Institute of Technology, and NASA's Lewis Research Center. A spinoff organization of OTTO is the "Buckeye Tourway Business and Industry Training, Research and Assistance Cooperative Extension Service" (TRACES), which coordinates the education, training, and technology transfer needs of a six-county area to promote economic stability and growth. Membership in TRACES is available to public and private service providers, and TRACES staff members are then available to provide training and technology transfer assistance, often by pooling the resources of several area agencies to provide package service to prospective clients

Brophy (1988) defines technology transfer as "the application of academic research results to economic development," and describes the facilities at the Universtiy of Arizona and at Arizona State University as they comprise the Arizona Board of Regents' technology transfer plan. The University of Arizona is one of the nation's top 20 research universities in terms of annual expenditure for research ($100 million), receiving about 70 percent of funding from federal agencies. A technology transfer office was established in 1986, consisting of a professional reporting to the Vice President for Research at UA and functioning to receive invention disclosures and other information from faculty members and to determine if and how to pursue licensing of the technology. This office publishes a periodic newsletter announcing and encouraging such innovation.

The Arizona Technology Development Corporation was organized by UA as a separate, for-profit company to nurture start-up companies created to commercialize technologies stemming from UA research. This corporation provides pre-venture capitol funding, helps with business plans, and provides managerial advice. And at Arizona State, technology transfer duties fall to the Industry Liaison Officer, who works under the Vice President for Research. Services of a patent attorney are available to this office, which also markets innovations directly or through Research Corporation Technologies, Inc. The ASU Hahn Center for Entrepreneurship and Innovation, in the ASU College of Business, participates in marketing and procuring start-up costs for supportive small businesses.

Numerous examples of corporate investment and adaptation of university facilities are given by Sims (1988), who cites Monsanto's investments at Washington University-St. Louis; Massachusetts Institute of Technology's R&D receipts from IBM, Bell Laboratories, and Honeywell Information Systems; and Hewlett-Packard's investments at Stanford and Cornell Universities. Further, Bok (1982) cites investments by Monsanto in Harvard University and by Exxon in MIT; both further examples of existing facilities being adapted to the uses of reciprocal technology transfer between industry and institutions of higher education.

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Small Business Centers

Purpose: Provide companies with the latest information on business systems. Help them apply these systems to their firms. Participate in the design and conduct market surveys. Assist firms to improve the quality of their services.

Potential Activities:

- Assist with the development of the business plan.
- Help firms design and conduct market research.
- Facilitate the use of up-to-date accounting and financial systems.
- Aid business improve their services to customers.
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SMALL BUSINESS CENTERS

Small business centers are often a part of larger adaptations of existing facilities, and much discussion thereto has thus been grandfathered into discussion of facilities in general. Worthy of separate mention here, however, are some unique independent innovations as well as the small business centers established in Illinois, Ohio, and Arizona as part of statewide technology transfer efforts.

The University of Arizona has helped organize the Arizona Technology Development Corporation, a separate, for-profit company that nurtures start-up companies created to commercialize technology stemming principally from the University of Arizona academic research programs. To date (Brophy, 1988), six companies have been started and ATDC holds an equity position in each on behalf of the university. ATDC places an officer on the board of each company to provide any necessary managerial advice as well as providing pre-venture capital and legal liaison. As of 1988, the ATDC was beginning to move from this hybrid organization -- private, for-profit but with officers who are UA employees -- toward increased corporate separateness so that UA is not viewed as operating in the private sector.

The Arizona State Research Institute (ASRI) is a non-profit organization under Arizona State University which was designed to act in the nature "of an engineering experiment station" to make laboratory facilities and faculty expertise available to local small business, and also to start new companies. This organization was very new in 1988, the date of cited publication; further information on this aspect of the small business center is surely forthcoming from Arizona.

Illinois has used their community college system to disseminate technology transfer, and thus has a much broader but shallower small business center network related thereto. Local industries have been invited in Illinois, however, to establish themselves as operating forces in the curricula of their local community colleges, and thereby impact the community college system specifically in much the way that small, independent business centers may exert a general influence.

In Ohio (Ohio Board of Regents, 1982), the Inter-University Energy Research Council (OIUERC) was developed to "promote, coordinate, facilitate, and evaluate energy research and seek support and accept grants for energy research and development." The Ohio Coal Research Laboratories Association, Inc. (OCRLA) similarly acts as a small business center by pursuing research and education programs on coal and coal-related problems, and acting as broker of this data for Ohio industry. The Ohio Urban University Demonstration Program provides training and education, research and assistance capabilities to help solve problems directly related to Ohio population centers. The Ohio Technology Transfer Organization (OTTO) utilizes the small-business-center concept by locating a full-time OTTO agent at each of fifteen technical and community college campuses to help small business enterprises learn and use current technical knowledge.

Sollie and Howell (1981) describe the Small Town Action Team (STAT), an innovative approach to the small-business-center concept. Small Town Action Teams are a variation of the Regional/Urban Design Assistance Team (American Institute of Architects, 1980), in which an interdisciplinary team moves into an area citing design or innovation need to work directly within the community, usually for about one week. The cited purpose of the team is to stimulate thought, focus attention, create an awareness of issues and opportunities, and make recommendations for action. The authors cite advantages to this mobile small-business-center approach as its interdisciplinary nature and its on-site work venue. Disadvantages are also cited: "To the 'nonvisualist" members of the team, the time available for data collection is less than satisfactory and provisions for follow-up are lacking."

Finally, Berrettini (1986) speculates on the small business center or material science and engineering (MSE) department of the year 2000, foreseeing simple computer codes to access a universe of technological innovations which may individually or collectively be adapted to the particular uses or needs of a specific innovation.

In conclusion, the concept of small business center is apparently subject to many and varied interpretation, none emerging in the literature as superior or more conclusive than the others. While each author or organization cited seemed to acknowledge the need for a central resource point for innovations seeking commercial outlet and, conversely, for business seeking innovation, the design of an optimal such resource point remains unclear. Perhaps as each of the cited approaches matures, the trend will focus toward physically discreet facilities and staffs, or perhaps simply toward office space within larger umbrella organizations. But at this time, no such focus is apparent, and the widely varying interpretations of small business center as a technology transfer concept suggest that such clarity may be a long way off.

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Climate, Communication & Linkage

Purpose: Create an environment that has potential or infrastructure in place. Communicate this capability and make it easy to use.

Potential Activities:

- Design a state/national/international model sharing the relationship of agencies and organizations.
- Determine the capability of various agencies, organizations and individuals.
- Develop a spirit of trust and cooperation among all participants.
- Develop missing components e.g. services potentially needed but not available.
- Conduct conferences and provide written materials to "get the word out."
- Provide "one stop shopping" for clients.
- Develop an on-line, self-initiated, interactive data base to match clients with available services. Also, however, have a person available to the human touch when needed.
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CLIMATE, COMMUNICATION, AND LINKAGE

Much of the technology transfer literature deals with various aspects of communications and linkage between innovation and industrial or commercial usage. Many different perspectives are expressed; all authors agree, however that effective technology transfer requires open communications between all parties involved.

Badewy (1989) discusses many barriers, as he identifies them, to technology transfer within U.S.corporations. He cites common conflicts between various functional groups, such as R&D and manufacturing, with attitudinal differences resulting in inhibited communications. Counterproductive territoriality is often allowed to flourish, according to Badewy, especially when research and development projects are introduced into other operations via paper rather than via key individuals. This paper vs. personnel transfer results in what the author refers to as the "not invented here" syndrome, by which personnel actually undermine rather than support a threatening project in order to protect their own images. He states, "On the other hand, if management recognizes the rather natural tendency for rivalry when groups are kept separated, it can design the organization for integration," and "when individuals are allowed to champion projects all the way from R&D to the marketplace, momentum and support are maintained."

Definitions of "workability" are also important to technology transfer communications, according to Badewy. An R&D professional, according to the author, may believe an invention "works" if it can be produced in a laboratory, whereas an operations manager might define workability as the ability of an innovation to survive manufacture at full-scale output and in the end-user market. He attributes this difference in perspectives on workability to differences in the time orientations of the various implementers; an operations manager is typically seen as producing results against unremitting deadlines and bottomline considerations, while the researcher is event oriented and less concerned with schedules. Further, R&D professionals generally value a theoretical basis for innovation, whereas operations managers are driven by the need to produce.

Badewy compares the climate of American business and that of the Japanese, citing several points which he considers key to technology transfer in the U.S.: (1) U.S. firms tend to spend inordinate amounts of time and money on research at the end of a product's life rather than committing, as the Japanese do, to new innovations or applications; (2) when U.S. firms do choose to invest in new technologies, they often set as goals perfection of the technology and mass marketing; the Japanese, on the other hand, tend to bypass perfection and appear willing to simply have something work passably well, taking the time instead to develop process engineering and write product specifications; (3) few U.S executives have technical backgrounds, but instead bring to their positions a focus on finances or sales, whereas Japanese managers are well-trained in all facets of their industry as a result of promotion policies that demand experience and competence in all aspects of the business; (4) manufacturing holds great status in Japan, while "blue-collar" work in the U.S. is often poorly paid and undervalued socially. This situation is exacerbated when managers will not deign or have not the training to do the work of those under their management, in contrast to Japanese managers who reach their managerial positions only by demonstrating full skills at the work they will supervise; (5) Japanese managers view their role as one of communicator rather than director or lecturer, while U.S. managers frequently spend their time on detailed instruction; (6) traditional U.S technology follows a linear or sequential process, whereas the holistic Japanese approach, which uses a multidisciplinary team to follow an innovation all through its development and marketing, appears far more effective for developing products quickly and flexibly.

Badewy identifies the position of "interfacer" as essential to communications and thus to effective technology transfer in the U.S., this position serving to span the boundaries between different group involved with a particular innovation to ensure that all parties are heard, all input received, and the innovation proudly "owned," at least psychologically, by all who participated in its development along the way.

Sims (1988) writes of the role of higher education in such corporate readaptation to the needs of technology transfer. He predicts that research and service units can act as troubleshooters when an industry is facing some special difficulty, or as advisers helping an industry evaluate its own projects or ideas. Further, he states that "whatever a firm's readaptation policy, an essential element of its evolution and implementation will be the availability, training, and development of its human resources." He quotes Wilson (1980), who discusses several linkage elements of successful partnerships between higher education and corporation, as stating, "Relationships must evolve through an increased understanding of the mission, goals, and relevant issues of both organizations." Wilson's recommendations are quoted: (1) understand the private sector's expectations and needs. Consulting, training, or other services provided by the university must be made clear to the corporation or faith in the "ivory tower" of academe is lost; (2) analyze the nature and individuality of each corporation; (3) be specific, recognizing that corporate managers need results which can be measured empirically; (4) maintain frequent communications with principle managers at the corporation; (5) university policies must be flexible to respond to corporate needs, and not impose academic rigors on corporate clients; (6) universities must adopt a philosophy which places them in an integral but not superior position in the global economy.

The Ohio Technology Transfer Organization is cited by Alter (1986) and by the Ohio Board of Regents (1982) as a model organization promoting a climate for open communications and linkage between the different participants in the process of technology transfer. OTTO agents, acting much like Badewy's proposed interfacers, are based at Ohio's 2-year colleges and serve the colleges, the students, and the many small- to medium-sized businesses which depend on local 2-year colleges to meet their entry-level employment needs, and which often offer students part-time employment while they are completing their educations. Further, according to Alter, "the addition of Continuing Education coordinators for specific instructional areas of the colleges has proved to be a viable solution to serving client requests and accessing the resources of the faculty to address specific needs."

The Ohio Board of Regents defines three phases of linkage development between the variety of organizations potentially involved in Ohio technology transfer efforts: exploration of needs and capabilities; development of linkage stategies; and implementation/evaluation of activities which would lay the foundation for such technology transfer in Ohio. Regional linkage conferences were held in several Ohio cities as part of the exploration phase, to (1) explore the means by which educational institutions can provide better services to meet the needs of business, industry, and government; (2) describe successful programs of cooperation which have already been initiated between business, industry, government, and higher education; and (3) serve as a catalyst for future action-oriented, problems solving activities. Among the conference results were a local resource directory, the design of a framework for regional work and learning councils, and provision of an opportunity for cooperation/-communication among diverse groups not accustomed to working together.

Hence it appears in the literature that, despite Badewy's criticisms of the U.S. technology transfer climate, communications and linkages have been forged, particularly between higher education and small local business. Perhaps if their model serves well, the larger corporations (of which Badewy largely wrote) will adapt their protocols likewise.

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GEO-Political

Purpose: Encourage an integration/linkage of Technology Transfer. Identify what Technology Transfer activities are being conducted in various parts of Wisconsin and the people, agencies, organizations and/or government units involved.

Potential Activities:

- Identify people, agencies and organizations involved in Technology Transfer.
- Catalog what is being done by each groups.
- Determine needed services that are not being provided.
- Encourage communication and interaction among these groups.
- Enter into joint programs and projects with on or more of these groups.
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GEO-POLITICAL

There exist volumes of literature dealing with technology transfer efforts in various regions of the country. Though many innovative and noteworthy approaches to technology transfer have been documented, many of these are dealt with elsewhere in these summaries and will not, therefore, be considered here; rather, only those technology transfer efforts designed by regional authorities to uniquely fit and capitalize on the geographic features and needs of their particular regions will be cited here.

William Blanton is a former deputy director of an Appalachian Local Development District under the Appalachian Regional commission, which has funded several technology transfer efforts including the North Carolina Technological Development Authority, the Tennessee Technology Foundation, the Alabama Technology Transfer Innovation and Productivity Program, and the Southern Technology Council. He cites (1987) the needs for technology transfer efforts in Appalachia, where "the problem is especially acute, since the Region has always lagged behind the rest of the country developmentally, and since, historically, it has depended to such a great extent on industries like coal and steel that are subject to boom and bust cycles." He gives examples within Appalachia of attempts to utilize technology transfer to overcome such regional vulnerabilities: Cherokee Mills, a fabric mill located in Sevierville, Tennessee, contracting with the Institute for Textile Technology (ITT) for direct technology transfer through on-site visits by ITT staff in an attempt to increase productivity and raise quality through additional training of employees and through full realization of the capabilities of the mill's complex machinery; the liaison developed between Raymond Tech of Binghamton, New York, and Broome Community College in Binghamton to provide computer-aided design (CAD) training for current Raymond Tech employees through the computer graphics expertise at Broome in an effort "to increase the investment [Raymond Tech] already had in its current employees rather than hire new workers with CAD training;" and Premis EMS (Engineering Molded Systems) of Lancaster, Ohio, a supplier of body parts for all Big Three auto makers, as they turned to the Ohio Technology Transfer Organization (OTTO) to resolve difficulties meeting specifications for paints and finishes because of problems with the Premix EMS heating system.

According to Blanton, "Despite a 1985 budget of only $1.7 million, OTTO made over 5,000 [such] business contacts and responded to 4,139 requests for assistance from 2,790 different companies. Most of the requests came from small business (over half of which were firms employing fewer than five persons), and the largest number of requests (32 percent) came from the manufacturing sector. OTTO agents reported a significant effect on state employment, with 1,601 jobs created by OTTO clients, 1,581 jobs retained, and another 1,583 jobs retained through retraining in 1984. Translated into tax dollars, those jobs mean nearly $3 million in tax revenue to the state." Blanton quotes OTTO consultant Bob Bailey who "doesn't see any conflict between the roles of university professor and technology transfer consultant." Bailey "doesn't agree with the idea that teaching has to take place in the university, or [with] the notion that education flows one way, from teacher to student." Rather, Bailey claims that OTTO espouses a two-way exchange of information, to enable research to produce changes in industry, and to see knowledge work in the lives of people as a functional reality instead of an abstraction."

The Ohio Technology Transfer Organization is not the only Ohio institution dealing with uniquely regional technology transfer issues, however. The Ohio Inter-University Energy Research Council (OIUERC) was established by the Ohio General Assembly in 1977 to help Ohio's twelve state universities and two private universities pursue prioretized research and technology transfer on coal research, alternative sources of energy, and energy conservation; the Ohio Coal Research Laboratories Association, Inc. (OCRLA) is a non-profit consortium of four Ohio universities whose purpose is to pursue research and education programs on coal and coal-related problems; and Ohio's Urban University Demonstration Program has organized Urban Study Centers on the campuses of Ohio's eight urban state universities to provide training, education, research, and assistance on issues directly arising from the specific population centers they serve.

The Illinois Community College Board (1989) reports on the recent technology transfer efforts made within that state, utilizing the community college system already in place. The Board acknowledges that regional technology transfer needs vary dramatically in a state such as Illinois, with one of the nation's largest population centers at one end and with a predominantly rural economy serving much of the rest of the state, and with industry scattered throughout the population areas. The fifty Illinois community colleges exist within thirty-nine districts, and each of the fifty colleges is comprehensive in that it provides extensive instructional and student support services to serve the needs of individuals as well as public services to address the needs of the community. The stated goal of the community college system in Illinois is to "prepare individuals for employment," and to that end, special educational programs are offered at given community colleges depending on the job market for that training within that discreet region of the state. For example, law and legal assistance programs are offered in only three of the state's fifty community colleges, while health, business/office, and trade/industrial are offered with some variations at each of the fifty institutions. The programs in parks and recreation management are offered at nine different campuses, each located near preserved state or federal properties, and such physical science programs as nuclear, chemical, and metalurgical are found at ten sites near industries directly employing program graduates. In addition, advanced technology centers are available under the supervision of and to support local industry: twenty-seven community colleges offer robotics training, and therefore have robotics equipment and/or labs; Illinois Valley Community college in Oglesby is establishing a model factory on campus with a flexible manufacturing system which will serve as a demonstration center for computer integrated manufacturing; and the College of Lake County in Grayslake recently opened the Automated Industrial Center to house its automated manufacturing programs, featuring a completely integrated system of computer-aided design, computer-aided manufacturing, and robotics, for examples.

Three different authors specifically mentioned efforts at technology transfer unique to Wisconsin. Bok (1982) cites the Wisconsin Alumni Research Fund, a foundation operated by graduates of the University of Wisconsin to license patents resulting from the work of faculty scientists. According to Bok, "Over sixty years, this effort has returned many millions of dollars to support research at the university." And, "Few institutions have come close to matching Wisconsin's record." The Association of American Colleges (1986) discusses the Technology Development Fund, established in 1983 by the state of Wisconsin along with its office of Industrial Research and Technology Transfer, with purposes "to promote, facilitate, and develop cooperative research and development programs and to guide facilities in their pursuit of commercial development of inventions." And Berrettini (1986) mentions a cooperation between the USDA Forest Products laboratory and the University of Wisconsin, which has produced "review-workshops" to yield specific, high-quality instructional units as an alternative to valuable faculty time in isolation for the purpose of textbook writing.

Finally, Breslin (1986) includes in her publication a state-by-state synopsis of technology transfer efforts. Though this list in not entirely comprehensive, and though many of the efforts cited by her are more generic and less geographically specific than those discussed here, the listing is useful for the diversity of efforts it represents. A copy is included as Appendix A.

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R & D Grants

Purpose: Provide small grants for promising R&D projects. Encourage R&D on innovative ideas.

Potential Activities:

- Fund small grants for promising R&D projects.
- Refer entrepreneurs and companies to R&D funding sources.
- Assist grant directors move their grant projects into the next phase.
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R & D GRANTS

Research and development funds appear to lie at the core of much technology transfer innovation and program development. There is considerable mention in the literature of R&D funds, including the procuring of such monies and the many uses to which the receiving institutions put such resources.

The National Science Foundation (1982) reports on several organizations which aim to fund technology transfer. The Council for Chemical Research, according to the NSF publication, grew out of meeting of research managers from major chemical companies, and exists to fund academic research and work toward forging new relationships between academic and industrial chemists and chemical engineers. The Semiconductor Research Association has set up a non-profit subsidiary, the Semiconductor Research Cooperative, which claims a 2-year budget of $50 million, and the intent of which is to encourage increased efforts by manufacturers and universities in long-term semiconductor research, and to add to the supply and quality of those holding professional degrees in the field. The American Electronics Association analyzed the national engineering shortage and petitioned their members to donate two percent of their research budgets against specific targets to alleviate this shortage, with a projected $50 million being made available to engineering departments in this way.

The National Science Foundation also reports on several large and visible agreements for long-term research collaborations between industry and universities, citing Harvard-Monsanto; Washington University-Mallinkrodt, Inc.; Harvard Medical School-Seagrams; MIT-Exxon; Carnegie Mellon-Westinghouse; Massachusetts General Hospital (Harvard)-Hoechst A.G.; and Washington University-Monsanto.

Bok (1982) elaborates on the aqcuisition and use of some of these industrial R&D funds by universities, quoting David Noble and Nancy Pfund (1980) as writing, "Monsanto gave Harvard what appears to be quite a lot of money, $23 million. In return, they received access to the facilities of Harvard Medical School, a resource they could not have created with many times that amount. The firm has in essence transformed a part of the publicsector social resource into a private-sector preserve." But

Bok, then Harvard president, counteracts these concerns with the clarification that, "such criticisms convey a distorted picture. Monsanto does not have special access to and entire school or department; it has only a working relationship with the two tenured scientists, and their research teams, who receive support from the company. In addition, the Harvard agreement expressly forbids restrictions on the publication of any discoveries that are made."

The National Science Foundation discusses briefly further incentives behind corporate philanthropy, stating that "corporations have administrative mechanisms for making deductible contributions to educational institutions for both research and educational purposes. Sometimes this is organized as a contributions office in the corporation, sometimes as a foundation."

The NSF observes that private investments in university research and development are not evenly distributed among academic fields, with endowed foundations invested principally in basic research in fields of biomedical and physical sciences, and with corporate foundations emphasizing engineering, technology, business, labor, and economics. Though the NSF publication acknowledges conflicting figures, they project "an educated guess that academic research supported by corporate gifts and grants roughly equals that supported by corporate contracts." For fiscal year 1980, the University of Wisconsin is cited as having received less that 3.6 percent of total R&D funds from industry; $2,615,000, or 1.9 percent of total U of W research and development expenditures, is the figure quoted as having been received from industry for that year.

Finally, Badewy (1989) discusses the relative merits and pitfalls of putting R&D monies into old technologies to improve and update them, vs. the use of such funds for new innovations only. He claims, "American companies are successful as the Japanese [companies] when they target new developments as important. The problem is that many U.S. firms spend too much time and money on research at the end of a product's life cycle."

Badewy attributes this American shortsightedness to the fact that too few top U.S. executives have technology backgrounds, citing the predominant sales focus of CEOs which often clashes with the flexibility needed for a successful transition from innovation to industrial use. Finally, he cites "interface management" between R&D, engineering, manufacturing, and marketing as absolutely critical to prompt and efficient technology transfer. However, many of these concerns have been addressed by initiatives mentioned by the National Science Foundation, so perhaps with such a pendulum swinging in the direction of American awareness of these issues, Badewy's concerns can be alleviated over time.

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Research, Development and Evaluation

Purpose: Experiment with the application of knowledge to new products and services. Develop and refine more effective technology transfer activities and programs. Expand and improve evaluation techniques that can be used to measure the effectiveness of technology transfer programs. Evaluate the impacts and effectiveness of technology transfer activities conducted by the VTAE System technology transfer centers.

Potential Activities:

- Acquire technology transfer research literature.
- Establish a file of technology transfer evaluation centers.
- Apply research design principles to the development and testing of technology transfer programs.
- Evaluate technology transfer activities and programs conducted in Wisconsin.
- Develop more effective strategies and techniques for evaluating technology transfer programs.
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RESEARCH, DEVELOPMENT, AND EVALUATION

Technology Transfer efforts appear from the literature notoriously difficult to evaluate. Many authors cite post facto differences, but seldom in the context of empirical data based on alternatives had technology transfer efforts not been undertaken.

However, Blanton (1987) reports that one client said of the help received thom the Ohio Technology Transfer Organization, "We really couldn't put a dollar and cents savings on it...We really couldn't provide to our customer the product they were looking for, and had we not been able to correct some of those things, that business would have gone to somebody else." Further, Blanton reports from Ohio Technology Transfer Organization records that 1984 efforts by that organization resulted in 1,601 new jobs, 1,581 retained jobs, and an additional 1,583 jobs retained through retraining.

The state of Ohio maintains such records, among other means, through the efforts of their Ohio Business, Education, and Government Alliance, a body created by the Ohio Board of Regents to make recommendations regarding extension services for business, industry, and social services. The Alliance is a state-level coordinating mechanism for the long-term collaborative efforts of education, business/industry, and government to improve Ohio's economy. A coordinating council, which includes representatives from business/industry, govermental agencies, colleges/universities, the Ohio General Assembly, and the Ohio Board of Regents, monitors the activities of three separate councils representing the three missions of Ohio colleges and universities: the Ohio Council for Education and Training represents the mission of instruction; the Ohio Council for Technology/Knowledge Transfer represents public service interests; and the Ohio Council for Research and Development assures a productive research climate.

Evaluation of state-wide technology transfer efforts in Ohio is thus a complex proposition, but is attended by representatives from all facets of education, business, industry, and grovenment through this pyramidal organization to share experiences, channel resources optimally, and assess end results of such efforts.

Badewy (1989) looks at technology transfer evaluation needs differently, citing Japanese successes in contrast to what he views as American shortcomings. First, he states that "manufacturing holds great status in Japan," and that "the technological illiteracy of those who run U.S. corporations is responsible for poor allocation of R&D resources." He observes, "Japanese managers are well trained as a result of promotion policies that demand experience in all aspects of a business, demonstration of technical competence, and the ability to work with others," and compares the preferred U.S. approach to innovation -- research, then design, and last manufacturing -- to the Japanese model which integrates research and design into all manufacturing stages.

Further, Badewy looks at personnel policies and corporate communications as tools of technology transfer evaluation, citing personnel policies in Japan which cultivate a strong sense of corporate loyalty, and the management's role of fostering communications rather than providing detailed and impersonal instruction, which he sees as the American paradigm.

Badewy advocates a more holistic, or integrated, approach to industry and technology transfer, rather than the linear model adhered to in this country to date. Given the successes of the multi-tiered, multimodal model presented by the state of Ohio, perhaps such an approach could well serve new technology transfer efforts.

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Finance and Governance

Purpose: Provide a means for policy development, administration and financial support.

Potential Activities:

- Develop a long range technology transfer plan for Wisconsin.
- Involve key legislators, regional representatives and local officials.
- Develop proposals for funding .
- Involve appropriate business, industries, government agencies and educational institutions at appropriate times.
- Develop policy boards.
- Develop a lean and efficient administrative organization.
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T/T Technology Transfer

FINANCE AND GOVERNANCE

There are many legal and legislative ramifications of technology transfer, ranging from deductibility of corporate research and development gifts to patent rights to royalties. Many of these issues are discussed in the technology transfer literature.

The National Science Board (1982) cites then-recent developments implemented federally to encourage the National Science Foundation and the National Bureau of Standards to "determine effective ways of stimulating non-Federal investment in research and development and of improving the application of research and development results." The Stevenson-Wyndler Technology Innovation Act of 1980 (P.L.96-480) represented an incorporation of several proposals designed to meet this need.

The 96th Congress passed the Uniform Federal Patent Policy Act of 1980 (P.L.(96517) for purposes of permitting universities, non-profit firms, and small businesses to take title to inventions arising from Federally funded R&D activities, and to encourage the commercialization of those innovations and technologies resulting from Federal sponsorship of university and industry-based research and development projects. Also in 1980, the Antitrust Division of the U.S. Department of Justice published its Antitrust Guide Concerning Research Joint Ventures, which was intended to clarify for private firms those conditions under which cooperative research ventures would be legal under then-present antitrust laws.

The 1981 Reagan administration demanded a more limited view of Federal funding for R&D ventures and instead provided incentives through tax legislation for corporate investment in research and development. The Economic Recovery Tax Act of 1981 (P.L.9734) increased by 25 percent the corporate tax credit allowable for R&D investment by industry; increased the allowable charitable deducation permitted for donations from industry to higher education institutions; and permitted depreciation over three years rather than the previous five for research equipment investments.

The National Science Board also discusses patent rights: "In general, inventions, innovations, discoveries, and improvements made with the use of university facilities or services, or during the course of regularly assigned duties, are the property of the university. Typically, university patent policies provide the inventor with between 25 and 50 percent of the royalties. If an invention occurs under a sponsored grant or contract, the sponsor's policy terms are controlling, although some universities try to have the sponsor follow the university's patent policy." As to patent management organizations (PMO's), the NSB reports that many universities have agreements with such, but research universities are increasingly developing their own patent management capabilities internally. Return on investment for such internal management is believed to be greater, and can have a significant impact on longevity of research programs. According to the NSB, "Companies usually feel comfortable with the university owning a patent arising from a sponsored grant or contract, particularly if the university is willing to provide an exclusive license for a certain time period."

Finally, the NSB discusses separately incorporated university foundations or institutes to serve as legal entities for administering sponsored research. This method provides a means of facilitating patent ownership and commercialization, and may function like a private contract research institute, but with the advantage of being backed by programs of research and education, thereby being particularly attractive to outside sponsors.

Bok (1982) also discusses university patent policies, citing such outside firms as Battelle and Research Corporation, which act as patent brokers between corporations and the educational institution. He also discusses the question of whether patents are truly consistent with the ideals of academic science, but states, "patents do not conflict with the principle of open access to knowledge. The rights acquired extend not to knowledge of a discovery as such, but only to its use for commercial purposes. In fact, the very idea of the patent system is to encourage inventors to make their discoveries known instead of keeping them secret to maintain an advantage over competitors." As to the debate over ownership of inventions funded by Federal dollars, Bok asserts, "the government's chief concern is not to earn royalty income but to encourage the application of scientific knowledge for socially productive purposes." He cites the then-recent Congressional decision to allow universities to own and license patents resulting from discoveries made under government research grants, believing that "by allowing universities and their professors to share in the rewards, Washington is likely to stimulate the development and commercial use of many more patentable discoveries, and any income obtained by the universities will help in turn to strengthen the quality of academic research."

The General Accounting Office (1988), however, reports from the government's point of view that "title to any inventions, computer software, and other technical data that an outside researcher makes while at a [federal] laboratory belongs to the federal agency funding the research, or is determined on a case-by-case basis." The GAO reports that seven of eight laboratories require visiting researchers to agree in advance to declare any inventions made at the laboratory and to waive the title rights to intellectual property developed at the federal laboratory. Few, if any, outside researchers have failed or been found to disagree with such stipulations.

So questions remain about ownership of innovations developed under federal grants, though legislation appears in place to simplify such questions when the liaison is between universities and the private sector. Ethical dilemmas remain possible for professors potentially lured from university duties to the specific needs of an R&D sponsor, but it is Bok's contention that if this occurs at all, it occurs to a negligible extent. Further, the technology transfer between industry and university serves both industry and university, as well as the general public, well in most cases, and as Bok concludes, "No academic institution can succeed by simply issuing or following rules. Only if professors care enough about their institutions to participate fully in the task of maintaining proper academic standards can their universities contribute to the useful application of knowledge."

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Venture Capital

Purpose: Assist entrepreneurs and small businesses acquire the financial resources they need to develop and/or improve their companies.

Potential Activities:

- Encourage the development of one or more venture capital funds in the region served.
- Identify potential sources of funds.
- Refer entrepreneurs and businesses to potential sources of funds.
- Counsel clients on financial options.
- Develop a venture or seed capital fund.
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VENTURE CAPITAL

Financing of technology transfer efforts is dealt with in the technology transfer literature almost exclusively through discussion of R&D funds, corporate philanthropy, or organizational fund raising. Only Bok (1982) discusses venture capital at all, and then only briefly and only with regard to university involvement.

Bok addresses the question of whether universities should assist their own faculty in forming companies to exploit their own discoveries. He claims, "Many high technology companies have risen from modest beginnings to earn millions of dollars. If a university could own a substantial share of even one or two of these ventures, it might gain a source of added revenue that could go far to remedy the gaps and deficiencies in the current patterns of funding for research."

However, Bok writes, "Commercial ventures of this kind are bound to lead an administration into conflicts with several constituencies. For example, any effort to go into business with professors will expose the administration to almost certain disagreements, not only with its faculty partners but also with professors who feel envious or upset that their own cherished schemes have not received comparable support." Bok continues, "Such commercial ventures will also impose upon the university unwelcome responsibilities it does not have as merely a tiny shareholder in a large established company."

Bok cites an operational premise which will certainly discourage potential venture capitalists as it will discourage those whose innovations require such funds: "It takes one thousand reported discoveries to produce one hundred patents; it takes one hundred patents to produce ten licenses; and only one license in ten will yield more than $25,000 per year."

Bok, Derek (1982), "Balancing Innovation and Responsibility," Change 14(6):16-25, September

Future Studies

Purpose: Conduct studies to determine emerging trends that will impact clients being served and related agencies. These studies could be very broadly based to include areas such as technology, management, environment, government and economics.

Potential Activities:

- Become involved with the World Future Society.
- Study global, national, regional and local developments.
- Interpret trends for specific applications.
- Work with the the Office of Technology Assessment.
- Conduct surveys and Delphi studies.
- Disseminate summary information.
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corporate and societal needs in the coming decade.

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Technology Education

Purpose: Provide education and training as necessary to establish a workforce potential at all levels of employment.

Potential Activities:

- Promote technology education at elementary, middle and secondary level.
- Provide teacher updating.
- Offer demonstrations and unique experiences for students and teachers.
- Provide broad based exploratory and technology literacy experiences for adults.
- Maintain high quality postsecondary vocational, technical, and university education.

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T/T Technology Transfer

Technology Deployment and Training

Purpose: Conduct needs assessment, identify "off-the-shelf technology," provide training, and stay with the project to insure successful implementation.

Potential Activities:

- Respond to requests for assistance.
- Initiate needs assessments.
- Define problems.
- Locate existing technology and management strategies for adoption.
- Assist with adopting promising practices.
- Design training to enable the practices to be used effectively
- Deliver training as needed.
- Monitor the project and make adjustments as required.

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T/T Technology Transfer